Tree Removals and Plantings

HVC Power Alignments:

- Pool Flatrock Kingsgrove HVC
- St Peters Tempe No. 1 & No. 2 HVC
- Marsh Ave / Wolli Creek HVC

Project Name: WestConnex New M5

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Document Approval

Rev.	Date	Prepared by	Reviewed by	Recommended by	Approved by	Remarks
00	06/06/16	ATC	CDS-JV			For issue
01	24/06/16	ATC	CDS-JV			For approval
Signature:						

Purpose of Report

This report was prepared by Australian Tree Consultants for CDS-JV to address condition B63 of Infrastructure Approval SS6788. This report specifically addresses trees along 3 cabling routes for the installation of High Voltage Customer (HVC) kiosks. These works are expected to be completed June through to August 2016 pending Commonwealth approval of the project. The scope of this report is limited to the trees outlined in this report.

Tree Removals and Plantíngs

B63 The SSI must be designed to retain as many trees as possible and provide a net increase in the number of replacement trees. The Proponent must commission an independent experienced and suitably qualified arborist, to prepare a comprehensive Tree Report(s) prior to removing any trees on the periphery and/or outside the construction footprint as identified in the figures in Section 6 of the document referred to in condition A2(b), including any tree(s) removed along Euston Road. The Tree Report may be prepared for the entire SSI or separate reports may be prepared for individual areas where trees are required to be removed. The report(s) must identify the impacts of the SSI on trees and vegetation within and adjacent to the construction footprint. The report(s) must include:

a) a visual tree assessment with inputs from the design, landscape architect, construction team;
b) consideration of all options to amend the SSI where a tree has been identified for removal, including realignment, relocation of services, redesign of or relocation of ancillary components (such as substations, fencing etc.) and reduction of standard offsets to underground services; and
c) measures to avoid the removal of trees or minimise damage to existing trees and is to ensure the health and stability of those trees to be protected. This includes details of any proposed canopy or root pruning, excavation works, site controls on waste disposal, vehicular access, storage of materials and protection of public utilities.

In the event that trees are to be removed, then replacement trees are to be planted within, or in close proximity to, the SSI boundary, including along Euston Road where feasible and reasonable. The location of the trees must be determined in consultation with the relevant council(s). The replacement trees are to have a minimum pot size of 75 litres. A copy of the report(s) must be submitted to the Secretary for approval prior to the removal, damage and/or pruning of any trees, including those affected by site establishment works. All recommendations of the report must be implemented by the Proponent, unless otherwise agreed by the Secretary.

Design, Landscape Architect, Construction Team Inputs

High Voltage power will be installed along the alignments as presented within the Arborist's report. Where available, pre-existing conduit runs have been selected for installation of cable, which will avoid impacts to trees. In these areas, trees have not been assessed. In other sections, trenching will occur in roadways and footpaths. In accordance with Ausgrid's network standards, the cable runs will require the installation of between one and six conduits, each 150mm in diameter running parallel. Conduits need to be installed at a depth of 1.2metres below ground level, with a trench width of 500mm. Conduit installation and temporary reinstatement will occur progressively, with installation crews working along the alignment. Following conduit installation, cables will be pulled and jointed to complete installation through the conduit, enabling HV supply to the kiosk. Permanent reinstatement (in accordance with network standards, council specifications and the UDLP where appropriate) will occur following commissioning of the service.

The HV alignments are largely predetermined by AusGrid. The alignment design process and pre-assessment for options included consideration of a number of pre-existing services in the ground and the room available to place new services. Existing utilitiies, tree roots, footpath widths, traffic and ROL requirements, adjacent foundations (services and adjacent properties) were all considered when determining the installation techniques.

Design and construction team have reviewed trees along the alignments and have assessed the removal and retention of trees by analysis of:

- Impacts on traffic and pedestrian flow
- Impacts on traffic, pedestrian and worker safety
- Ability to access the alignments and carry out the work
- The number of in ground services in the surrounding area and if there is space available to deviate around trees
- Assumption that in some the alignment locations pre-existing services have already been installed and during their installation appropriate tree management has been undertaken. In those instances the HV power should present minimal tree inference.

The final assessment by the arborist whether trees should be retained or removed has been based on standard arboricultural assessment (as documented in the report). Whilst excavation within the tree protection zone is required for a large number of trees, it is envisaged that the majority can be retained through the implementation of the arborist's recommendations. However, it must be noted that excavation may reveal further information on a tree that would then warrant its removal. The Independent Arborist will be consulted on all occasions where there is root interference to determine if the tree can be managed and retained or require removal. If removal of a tree identified for retention in this report is required, an arborist's report will be prepared and submitted to DP&E prior to removal in accordance with the Condition of Approval. Final outcomes will be documented. All works will be performed in accordance with Ausgrid's Environmental Handbook for Construction and Maintenance and the project's AFMP.

The following tree report was prepared by Australian Tree Consultants with the following input from the Design, Landscape Architect and Construction Teams

Design Manager		
Input / Review	There is little opportunity to preserve the trees identified for removal by the construction team, due to either the existing hazardous condition of the trees or construction / alignment constraints. Construction personnel attended with arborist to walk the alignments and discuss constraints as appropriate.	
Signature	[redacted] – Design Manager	[redacted]

Landscape Architect		
Input / Review	There are no possibilities to preserve any of the trees nominated for removal other than where already nominated in the report. The final urban design and landscape plan will address replacement of these trees.	
Signature	[redacted] – Landscape Architect, Urban Design Manager	[redacted]

Construction Team		
Pool Flatrock Kingsgrove HVC	A total of 95 trees were surveyed along the alignment during a walkover of the route with the arborist and construction Superintendent on 27th May. The specific alignment should generally provide sufficient space for trees not to be greatly impacted. Preexisting, available conduit has been selected for installation of cable in the northern section of the alignment.	
St Peters Tempe No. 1 & No. 2 HVC	A total of 38 trees were surveyed along the alignment during a walkover of the route with the arborist and Construction Superintendent on the 27th May. It was noted that the alignment is restricted due to narrow streets with trees on the footpath leaving minimal room for running cable. Although there is an expectation that most trees along the alignment will be retained (including high value Figs in Unwins Bridge Road), up to 19 trees will need to be removed (including 18 on Silver Street) due to the close vicinity of trees to the required trenching alignment. For Silver Street, a number of alternative options have been identified and assessed. Excavation solely by non-destructive excavation techniques is not feasible, as this method requires an increased width of trench which further adversely affects trees and undermines property structures (also restricting property access, and increasing noise impacts). Underbores are impractical in this location given the number of ducts required, the close proximity of ducts and proximity adjacent services. The entry and exit points of the potential bore locations are congested with existing services (gas, sewer, water & communications).	
Marsh Ave / Wolli Creek	A total of 40 trees were surveyed along the alignment during a walkover of the route with the arborist and construction Superintendent on the 27th May. Generally, sufficient space exists so that most trees would be expected to be retained. Two trees have been identified that conflict with the proposed under-bore of Marsh Street. Three other trees have been identified for removal.	
Signature	[redacted] – M&E Director / Construction Manager	[redacted]

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Date: 22nd June 2016

To [redacted]
Environment & Sustainability Manager
CDS-JV (New M5)

Re – Arboricultural Reports

I refer to your request to undertake site reviews of three (3) WestConnex Kiosk HVC.

Australian Tree Consultants Pty Ltd undertook the site inspections on 27th – 28th May, 2016.

If you require any further information in relation to this report, please contact us on 0418 474 796.

Yours sincerely

Hugh Taylor
Director Australian Tree Consultants
Registered Consulting Arborist No 1268
BA (L) Major in Wilderness Management/Outdoor Education
Diploma Horticulture – Arboriculture (Level 5)
Arborist/ Tree Surgeon/ Horticulturist
Certificate IV Occupational Health & Safety

ARBORIST REPORT

Client CDS-JV New M5 (WestConnex Stage 2)

Report Prepared By Australian Tree Consultants Pty. Ltd.

Date 22nd June 2016

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INTRODUCTION

CDS-JV (New M5 Project) has commissioned Australian Tree Consultants Pty Ltd (ATC) to prepare an Arboricultural report on three (3) routes for the installation of High Voltage Customer Kiosks for the use by the Project.

Australian Tree Consultants Pty Ltd undertook the site inspections on 27th – 28th May 2016. Inspections and all field work were undertaken by Hugh Taylor Consulting Arborist for Australian Tree Consultants with Ward Hogan from CDS-JV who provided design drawings and construction site layout plans and interpretation.

The three (3) routes to enable the installation of the HVC Kiosks were inspected and they include:

- WestConnex Stg 2 Establish HVC “KL” type kiosk S.76819 Pool Flatrock Kingsgrove. Site plans 1 – 14 by UEA Electrical.

- WestConnex STG 2 Establish two HVC “KL” type kiosks. S. 76844 WestConnex St Peters Temp No 1. S. 76844 WestConnex St Peters Temp No 2 Princes Hwy St Peters. Site plans 1 – 13 by UEA Electrical.

- WestConnex Stg 2 Establish two HVC “KL” type kiosk S.76825 Marsh Valda No 2. WestConnex Stg 2 March Ave Wolli Creek. Site plans 1 – 13 by UEA Electrical.

METHODOLOGY

All directions on route of the installation of the HVC were given to ATC by the representative of CDS-JV. Site plans were reviewed prior to starting surveying and inspection of the trees. The route of the proposed installation of the HVC was walked and any tree that was to be potentially impacted by the installation was recorded. Australian Tree Consultants is an independent Consulting Arborist company and all staff are qualified to AQF Level 5. The Infrastructure Approval for the project requires that all trees be inspected by a consulting arborist and that the following Arboricultural report contain:-

- A visual tree assessment with inputs from the design, landscape architect, construction team.

- Consideration of all options to amend the plan where a tree has been identified for removal, including realignment, relocation of services, redesign of or relocation of ancillary components (such as substations, fencing etc.) and reduction of standard offsets to underground services.

- Measures to avoid the removal of trees or minimize damage to existing trees and to ensure the health and stability of those trees to be protected. This includes details of any proposed canopy or root pruning, excavation works, site controls on waste disposal, vehicular access, the storage of materials and protection of public utilities.

Trees were located with our GNSS sub cm survey equipment. All data is collected in Map Zone 56 and Map Grid of Australia.

TREE PROTECTION

With use of the data collected for each tree, the Tree Protection Zone and Structural Root Zones have been calculated. The Tree Protection Zone (TPZ) is the means by which to protect trees on development sites and should protect both roots and crown spread simultaneously. The TPZ should be considered as protected, that is it should be isolated from any construction disturbance unless previously agreed with the Project Arborist. The dimensions of the TPZ are determined from the Diameter of the Tree at Breast Height (DBH).

The second data collected for tree protection is the Structural Root Zone (SRZ) which is an area considered essential for tree stability: loss of roots in this area is likely to cause the tree to become unstable in the ground.

The dimensions of the SRZ are determined from the Diameter of the Tree taken above the root flare.

Any excavation within the TPZ or the SRZ must be approved by the Project's consulting arborist prior to any works within this area. See Appendix 1. Tree Protection on Construction Sites.

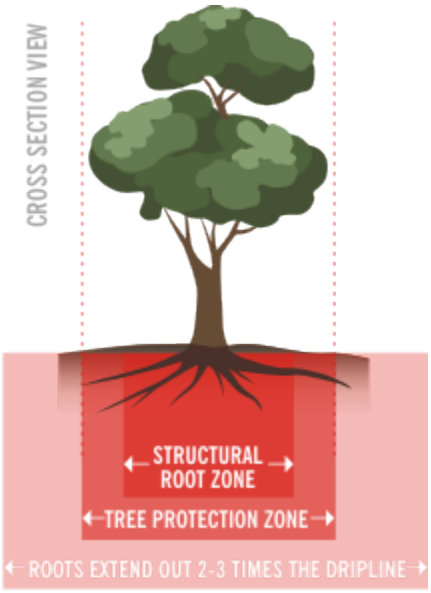


Fig 1. TPZ and SRZ protection zones.

RESULTS

Site 1: WestConnex Stg 2 Establish HVC "KL" type kiosk S.76819 Poole Flatrock Kingsgrove. Site plans 1 – 14 by UEA Electrical

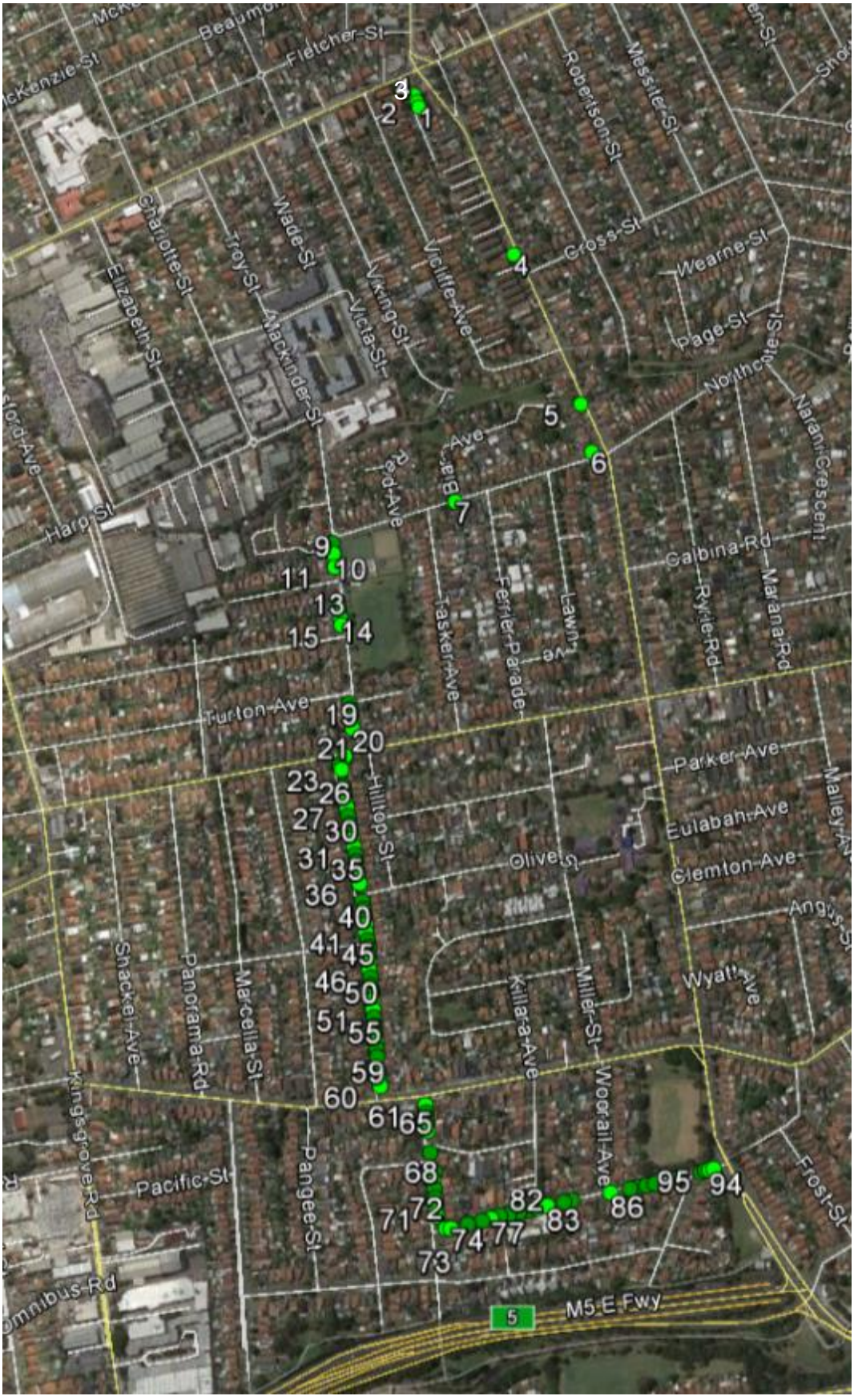
Map 1. Route of Poole Flatrock Kingsgrove HVC.

Trees located within close proximity to the proposed installation line have been included within this document. In some cases, conduit is prexisting and available for use to install cable (cable pulling via access pits). In these locations, disturbance to existing trees will not occur and these trees have not been surveyed.

In total ninety five (95) trees were surveyed for this section of HVC installation. All trees surveyed were native trees. It is anticipated that HV installation will have limited impact to the trees identified, with some works required within the TPZ. However, these works, managed in

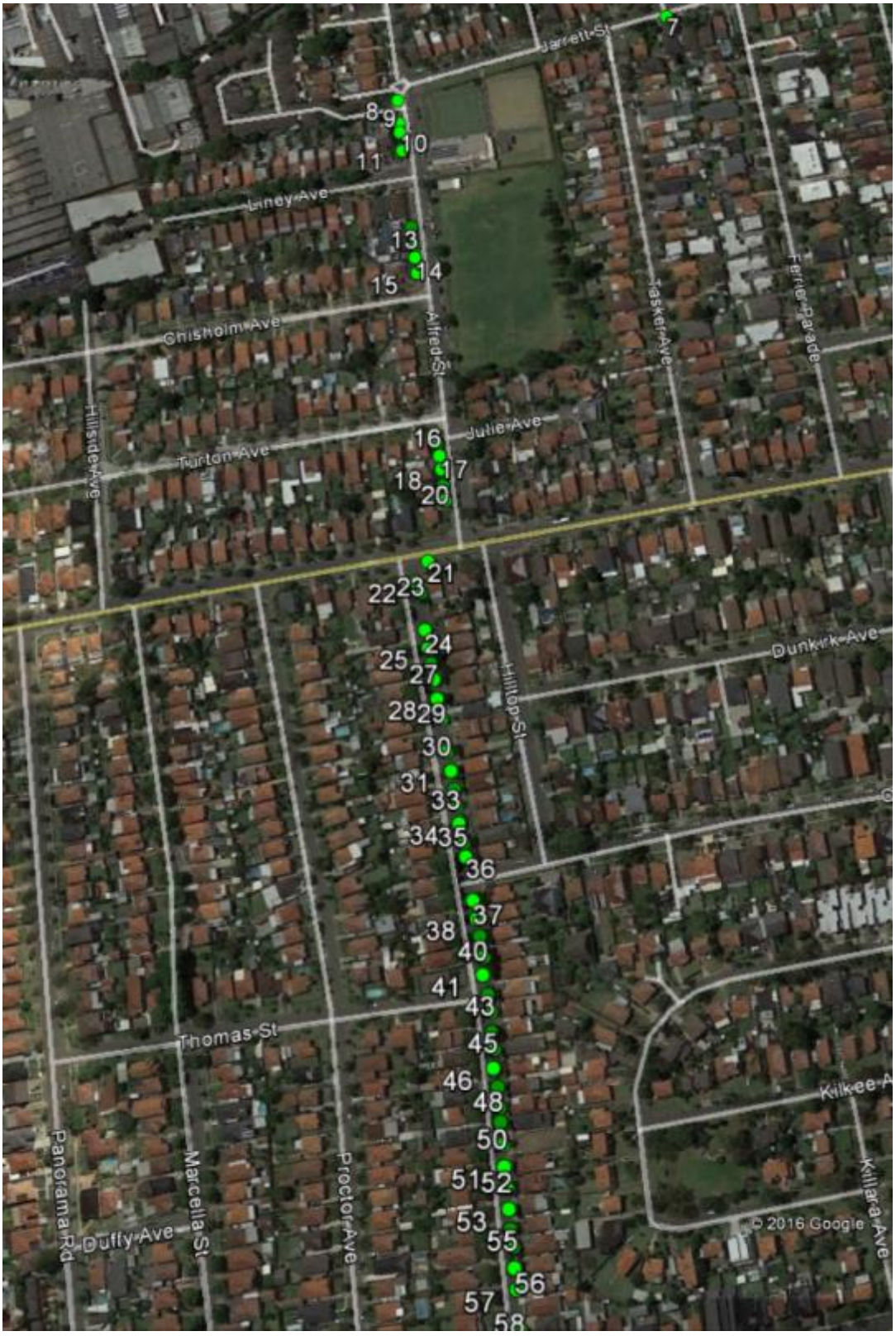
accordance with the recommendations of this report, should not require the removal of these trees.

Trees will be retained wherever possible; however, some trees may require removal during works if significant root systems are encountered (with alignment, network design and construction constraints limiting alternative options). An arborist will be consulted to recommend the approporiate course of action (in accordance with Ausgrid's network Standard NS174C), and a subseqeunt report prepared and submitted to DP&E prior to removal.

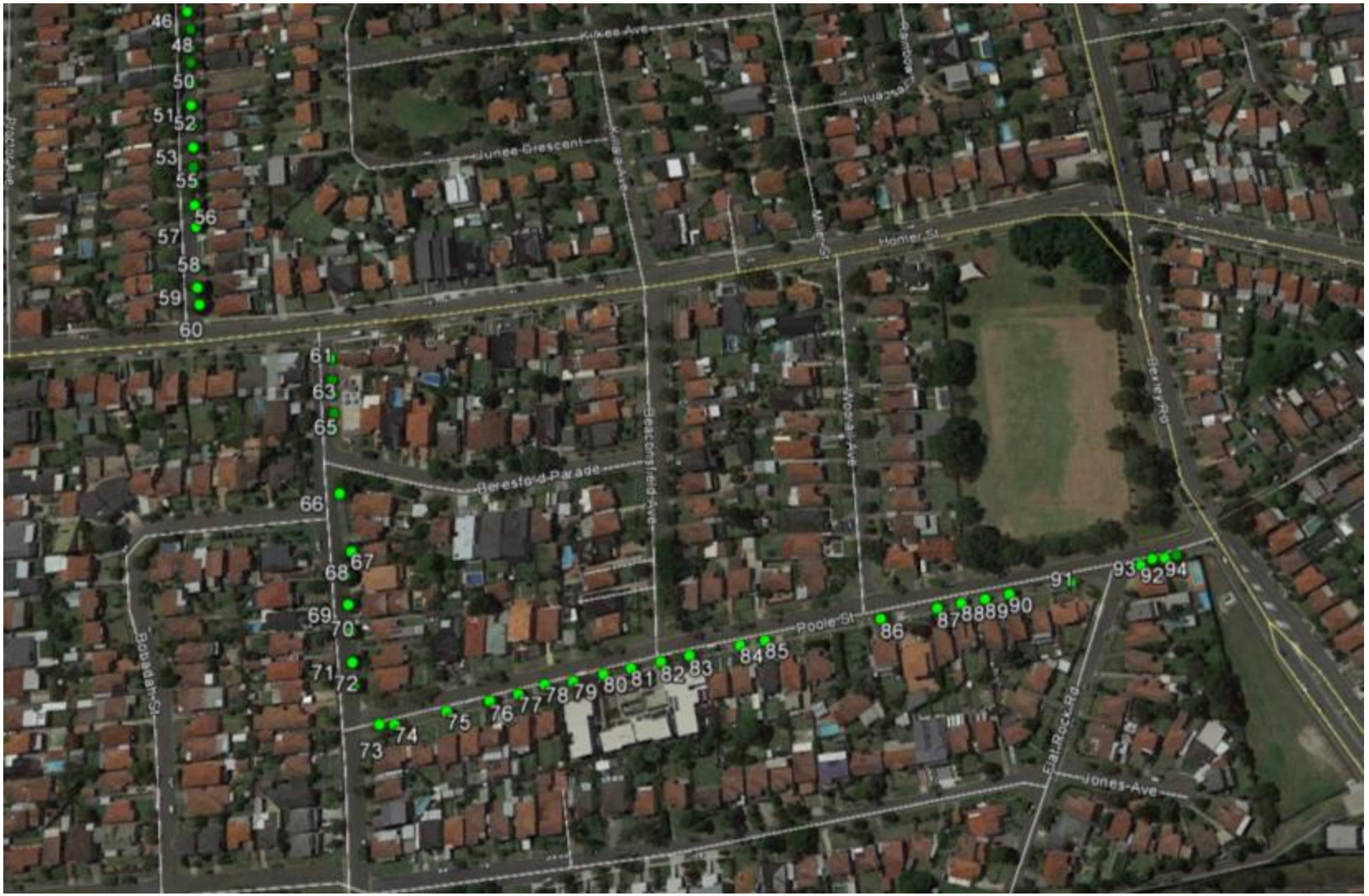


Map 2 Poole Flatrock Kingsgrove HVC overall map of marked trees.

Map 3 Poole Flatrock Kingsgrove HVC map close up view of trees.



Map 4 Poole Flatrock Kingsgrove HVC map close up view of trees.



Map 5 Poole Flatrock Kingsgrove HVC map close up view of trees.

POOLE FLATROCK KINGSGROVE HVC

NO	BOTANICAL_NAME	HEIGHT	SPREAD	DBH MM	HEALTH	STRUCTURE	TPZ (m)	SRZ Radius (m)	RETENTION VALUE	OUTCOME	Easting	Northing	MSL
1	Callistemon viminalis	4	3	250	POOR	POOR	3	1.85	LOW	RETAIN	324776.305	6245221.08	38.294
2	Callistemon viminalis	5	3	250	GOOD	MODERATE	3	1.85	MEDIUM	RETAIN	324772.897	6245229.78	37.898
3	Callistemon viminalis	5	3	200	MODERATE	MODERATE	2.4	1.68	MEDIUM	RETAIN	324766.035	6245242.39	37.572
4	Callistemon viminalis	5	2	250	GOOD	MODERATE	3	1.85	MEDIUM	RETAIN	324944.437	6244975.06	28.921
5	Callistemon viminalis	4	3	300	MODERATE	MODERATE	3.6	2	MEDIUM	RETAIN	325065.196	6244727.13	19.798
6	Callistemon viminalis	4	3	200	GOOD	MODERATE	2.4	1.68	MEDIUM	RETAIN	325087.763	6244647.13	22.955
7	Callistemon viminalis	5	4	300	MODERATE	MODERATE	3.6	2	MEDIUM	RETAIN	324869.897	6244560.63	22.686
8	Callistemon viminalis	7	6	450	GOOD	MODERATE	5.4	2.37	MEDIUM	RETAIN	324676.866	6244488.43	24.711
9	Callistemon viminalis	8	7	350	MODERATE	MODERATE	4.2	2.13	MEDIUM	RETAIN	324679.064	6244470.45	25.999
10	Elaeocarpus reticulatus	4	1	100	GOOD	GOOD	2	1.5	MEDIUM	RETAIN	324680.309	6244463.05	27.78
11	Callistemon viminalis	7	10	500	GOOD	MODERATE	6	2.47	MEDIUM	RETAIN	324683.066	6244448.71	26.734
12	Callistemon viminalis	13	11	600	GOOD	GOOD	7.2	2.67	HIGH	RETAIN	324693.535	6244389.1	27.582
13	Callistemon viminalis	5	4	300	MODERATE	POOR	3.6	2	LOW	RETAIN	324696.038	6244375.78	27.968
14	Callistemon viminalis	9	7	500	MODERATE	MODERATE	6	2.47	MEDIUM	RETAIN	324697.674	6244365.96	28.186
15	Callistemon viminalis	12	10	500	GOOD	MODERATE	6	2.47	MEDIUM	RETAIN	324699.991	6244354.37	28.178
16	Callistemon viminalis	7	6	450	MODERATE	MODERATE	5.4	2.37	MEDIUM	RETAIN	324722.011	6244227.69	29.938
17	Callistemon viminalis	9	8	450	MODERATE	MODERATE	5.4	2.37	MEDIUM	RETAIN	324724.552	6244218.5	30.075
18	Callistemon viminalis	9	8	550	MODERATE	MODERATE	6.6	2.57	MEDIUM	RETAIN	324726.496	6244208.79	29.931
19	Callistemon viminalis	9	8	450	MODERATE	MODERATE	5.4	2.37	MEDIUM	RETAIN	324728.476	6244197.5	30.181
20	Callistemon viminalis	12	14	650	GOOD	MODERATE	7.8	2.76	MEDIUM	RETAIN	324730.285	6244186.97	30.098
21	Callistemon viminalis	3	2	150	POOR	MODERATE	2	1.5	LOW	RETAIN	324721.046	6244143.15	31.376

POOLE FLATROCK KINGSGROVE HVC

NO	BOTANICAL_NAME	HEIGHT	SPREAD	DBH MM	HEALTH	STRUCTURE	TPZ (m)	SRZ Radius (m)	RETENTION VALUE	OUTCOME	Easting	Northing	MSL
22	Lophostemon confertus	10	7	450	MODERATE	POOR	5.4	2.37	MEDIUM	RETAIN	324713.949	6244128.2	31.665
23	Lophostemon confertus	10	12	650	MODERATE	MODERATE	7.8	2.76	MEDIUM	RETAIN	324717.753	6244121.23	31.488
24	Lophostemon confertus	3	3	150	MODERATE	MODERATE	2	1.5	LOW	RETAIN	324722.085	6244095.01	31.684
25	Callistemon species	3	2	150	MODERATE	POOR	2	1.5	LOW	RETAIN	324725.127	6244082.31	31.595
26	Lophostemon confertus	5	9	650	MODERATE	MODERATE	7.8	2.76	MEDIUM	RETAIN	324727.627	6244071.88	31.925
27	Lophostemon confertus	6	11	700	MODERATE	MODERATE	8.4	2.85	MEDIUM	RETAIN	324730.391	6244060.92	32.097
28	Lophostemon confertus	11	14	650	MODERATE	MODERATE	7.8	2.76	MEDIUM	RETAIN	324733.293	6244047.68	30.688
29	Lophostemon confertus	4	3	200	MODERATE	GOOD	2.4	1.68	MEDIUM	RETAIN	324737.203	6244034.27	32.292
30	Lophostemon confertus	9	12	650	MODERATE	MODERATE	7.8	2.76	MEDIUM	RETAIN	324742.193	6244011.84	33.021
31	Lophostemon confertus	9	12	500	MODERATE	MODERATE	6	2.47	MEDIUM	RETAIN	324745.989	6243998.75	35.253
32	Lophostemon confertus	5	8	450	MODERATE	MODERATE	5.4	2.37	MEDIUM	RETAIN	324749.205	6243986.68	32.157
33	Lophostemon confertus	4	7	350	MODERATE	MODERATE	4.2	2.13	MEDIUM	RETAIN	324750.97	6243975.72	34.741
34	Lophostemon confertus	5	7	550	MODERATE	MODERATE	6.6	2.57	MEDIUM	RETAIN	324753.705	6243963.72	35.181
35	Lophostemon confertus	13	10	550	POOR	MODERATE	6.6	2.57	LOW	RETAIN	324757.231	6243951.3	36.004
36	Lophostemon confertus	5	9	400	MODERATE	MODERATE	4.8	2.25	MEDIUM	RETAIN	324759.526	6243941.75	36.552
37	Lophostemon confertus	9	13	650	MODERATE	MODERATE	7.8	2.76	MEDIUM	RETAIN	324766.149	6243913.37	37.923
38	Lophostemon confertus	5	8	450	GOOD	MODERATE	5.4	2.37	MEDIUM	RETAIN	324769.361	6243901.4	38.491
39	Lophostemon confertus	10	12	750	MODERATE	MODERATE	9	2.93	MEDIUM	RETAIN	324772.132	6243890.28	39.099
40	Lophostemon confertus	14	12	850	MODERATE	MODERATE	10.2	3.09	MEDIUM	RETAIN	324775.201	6243877.29	40.542
41	Lophostemon confertus	14	11	700	MODERATE	MODERATE	8.4	2.85	MEDIUM	RETAIN	324775.548	6243865.53	49.816
42	Lophostemon confertus	8	6	650	POOR	POOR	7.8	2.76	LOW	RETAIN	324779.724	6243852.97	41.06

POOLE FLATROCK KINGSGROVE HVC

NO	BOTANICAL_NAME	HEIGHT	SPREAD	DBH MM	HEALTH	STRUCTURE	TPZ (m)	SRZ Radius (m)	RETENTION VALUE	OUTCOME	Easting	Northing	MSL
43	Lophostemon confertus	5	5	300	MODERATE	MODERATE	3.6	2	MEDIUM	RETAIN	324782.179	6243842.44	40.817
44	Lophostemon confertus	10	9	800	MODERATE	MODERATE	9.6	3.01	MEDIUM	RETAIN	324783.675	6243829.3	42.218
45	Lophostemon confertus	12	10	700	MODERATE	MODERATE	8.4	2.85	MEDIUM	RETAIN	324785.525	6243819.11	42.953
46	Lophostemon confertus	8	10	500	MODERATE	MODERATE	6	2.47	MEDIUM	RETAIN	324785.997	6243806.84	43.93
47	Lophostemon confertus	9	14	600	MODERATE	MODERATE	7.2	2.67	MEDIUM	RETAIN	324789.619	6243795.26	43.579
48	Lophostemon confertus	9	13	700	MODERATE	MODERATE	8.4	2.85	MEDIUM	RETAIN	324791.109	6243782.79	51.291
49	Lophostemon confertus	9	12	650	MODERATE	MODERATE	7.8	2.76	MEDIUM	RETAIN	324792.583	6243773.74	46.383
50	Lophostemon confertus	5	7	350	POOR	MODERATE	4.2	2.13	LOW	RETAIN	324794.843	6243759.82	45.028
51	Lophostemon confertus	6	10	450	MODERATE	MODERATE	5.4	2.37	MEDIUM	RETAIN	324796.656	6243746.5	46.025
52	Lophostemon confertus	7	10	650	MODERATE	MODERATE	7.8	2.76	MEDIUM	RETAIN	324799.001	6243733.63	45.594
53	Lophostemon confertus	7	12	500	MODERATE	MODERATE	6	2.47	MEDIUM	RETAIN	324800.944	6243720.95	46.008
54	Lophostemon confertus	9	14	500	MODERATE	MODERATE	6	2.47	MEDIUM	RETAIN	324802.782	6243708.79	46.604
55	Lophostemon confertus	12	10	1200	MODERATE	MODERATE	14.4	3.57	MEDIUM	RETAIN	324804.942	6243698.72	48.719
56	Lophostemon confertus	9	11	450	MODERATE	MODERATE	5.4	2.37	MEDIUM	RETAIN	324806.474	6243685.87	47.866
57	Lophostemon confertus	8	11	450	MODERATE	MODERATE	5.4	2.37	MEDIUM	RETAIN	324808.885	6243673.3	48.068
58	Lophostemon confertus	8	10	450	MODERATE	MODERATE	5.4	2.37	MEDIUM	RETAIN	324812.079	6243649.71	48.368
59	Lophostemon confertus	9	11	650	MODERATE	MODERATE	7.8	2.76	MEDIUM	RETAIN	324813.693	6243638.44	49.085
60	Lophostemon confertus	12	9	500	MODERATE	MODERATE	6	2.47	MEDIUM	RETAIN	324815.765	6243629.07	48.127
61	Melaleuca linariifolia	4	3	250	GOOD	MODERATE	3	1.85	MEDIUM	RETAIN	324886.884	6243601.09	46.175
62	Melaleuca linariifolia	5	5	400	MODERATE	MODERATE	4.8	2.25	MEDIUM	RETAIN	324888.959	6243589.26	46.003
63	Melaleuca linariifolia	5	3	300	POOR	MODERATE	3.6	2	LOW	RETAIN	324889.97	6243581.17	45.822

POOLE FLATROCK KINGSGROVE HVC

NO	BOTANICAL_NAME	HEIGHT	SPREAD	DBH MM	HEALTH	STRUCTURE	TPZ (m)	SRZ Radius (m)	RETENTION VALUE	OUTCOME	Easting	Northing	MSL
64	Melaleuca linariifolia	6	3	500	MODERATE	MODERATE	6	2.47	MEDIUM	RETAIN	324891.527	6243571.43	45.55
65	Melaleuca linariifolia	5	3	300	MODERATE	MODERATE	3.6	2	MEDIUM	RETAIN	324892.305	6243562.2	44.96
66	Melaleuca linariifolia	3	2	150	POOR	MODERATE	2	1.5	LOW	RETAIN	324897.465	6243529.17	41.751
67	Melaleuca linariifolia	3	5	300	MODERATE	MODERATE	3.6	2	MEDIUM	RETAIN	324905.094	6243499.72	36.091
68	Melaleuca linariifolia	6	5	600	MODERATE	POOR	7.2	2.67	MEDIUM	RETAIN	324902.755	6243487.33	34.872
69	Melaleuca styphelioides	6	5	500	MODERATE	MODERATE	6	2.47	MEDIUM	RETAIN	324904.743	6243472.95	33.077
70	Melaleuca linariifolia	5	5	650	MODERATE	MODERATE	7.8	2.76	MEDIUM	RETAIN	324906.755	6243459.03	31.523
71	Melaleuca linariifolia	6	5	550	MODERATE	MODERATE	6.6	2.57	MEDIUM	RETAIN	324908.562	6243443.99	30.014
72	Melaleuca linariifolia	7	5	450	MODERATE	MODERATE	5.4	2.37	MEDIUM	RETAIN	324910.318	6243431.75	29.091
73	Callistemon viminalis	6	4	350	MODERATE	MODERATE	4.2	2.13	MEDIUM	RETAIN	324924.42	6243413.31	26.397
74	Callistemon viminalis	9	5	400	MODERATE	MODERATE	4.8	2.25	MEDIUM	RETAIN	324932.071	6243413.26	28.129
75	Callistemon viminalis	4	3	150	MODERATE	MODERATE	2	1.5	MEDIUM	RETAIN	324958.156	6243420.13	29.732
76	Callistemon viminalis	5	4	350	MODERATE	MODERATE	4.2	2.13	MEDIUM	RETAIN	324979.74	6243425.7	30.479
77	Callistemon viminalis	7	5	450	MODERATE	MODERATE	5.4	2.37	MEDIUM	RETAIN	324994.155	6243429.2	31.033
78	Callistemon viminalis	7	5	400	MODERATE	POOR	4.8	2.25	LOW	RETAIN	325007.178	6243434.34	31.9
79	Callistemon viminalis	6	5	300	MODERATE	MODERATE	3.6	2	MEDIUM	RETAIN	325021.432	6243436.2	31.154
80	Callistemon viminalis	4	4	250	GOOD	MODERATE	3	1.85	MEDIUM	RETAIN	325036.466	6243440.3	31.017
81	Callistemon viminalis	4	3	250	POOR	MODERATE	3	1.85	LOW	RETAIN	325050.281	6243443.62	30.823
82	Callistemon viminalis	4	4	350	MODERATE	MODERATE	4.2	2.13	MEDIUM	RETAIN	325065.308	6243447.26	30.825
83	Callistemon viminalis	5	4	400	MODERATE	MODERATE	4.8	2.25	MEDIUM	RETAIN	325079.693	6243450.48	30.467
84	Callistemon viminalis	4	3	100	POOR	POOR	2	1.5	LOW	RETAIN	325105.352	6243456.25	30.136

POOLE FLATROCK KINGSGROVE HVC

NO	BOTANICAL_NAME	HEIGHT	SPREAD	DBH MM	HEALTH	STRUCTURE	TPZ (m)	SRZ Radius (m)	RETENTION VALUE	OUTCOME	Easting	Northing	MSL
85	Callistemon viminalis	4	2	200	MODERATE	MODERATE	2.4	1.68	MEDIUM	RETAIN	325118.054	6243459	29.923
86	Callistemon viminalis	5	3	400	GOOD	MODERATE	4.8	2.25	MEDIUM	RETAIN	325177.235	6243471.71	27.976
87	Callistemon viminalis	4	5	300	MODERATE	MODERATE	3.6	2	MEDIUM	RETAIN	325206.571	6243478.04	25.941
88	Callistemon viminalis	6	4	300	MODERATE	MODERATE	3.6	2	MEDIUM	RETAIN	325219.144	6243480.9	25.018
89	Callistemon viminalis	4	2	150	MODERATE	MODERATE	2	1.5	LOW	RETAIN	325231.564	6243483.57	24.113
90	Callistemon viminalis	4	4	200	MODERATE	MODERATE	2.4	1.68	MEDIUM	RETAIN	325244.28	6243486.61	22.993
91	Callistemon viminalis	3	2	200	POOR	MODERATE	2.4	1.68	MEDIUM	RETAIN	325276.975	6243493.8	20.492
92	Callistemon viminalis	5	4	300	MODERATE	MODERATE	3.6	2	MEDIUM	RETAIN	325314.412	6243504.03	18.937
93	Callistemon viminalis	6	4	400	MODERATE	MODERATE	4.8	2.25	MEDIUM	RETAIN	325320.647	6243507.72	23.238
94	Callistemon viminalis	5	3	300	MODERATE	MODERATE	3.6	2	MEDIUM	RETAIN	325327.498	6243508.28	18.199
95	Callistemon viminalis	3	1	100	POOR	POOR	2	1.5	LOW	RETAIN	325333.817	6243510.09	17.719

Site 2: WestConnex STG 2 Establish two HVC "KL" type kiosks. S. 76844 WestConnex St Peters Temp No 1. S. 76844 WestConnex St Peters Temp No 2 Princes Hwy St Peters. Site plans 1 – 13 by UEA Electrical.

Map 6 Route of St Peters proposed HVC.

Trees located within close proximity to the proposed installation line have been included within this document. There is no availabe pre-existing conduit along this route that can be utilised for these works.

Thirty eight (38) trees were surveyed for this section of HVC installation. All trees surveyed were native trees. It is anticipated that HV installation will have some impacts to the trees identified, particularly Tree 2 at Robert Lane and Trees 4-21 located along Silver Street. Options for retaining trees in these areas have been assessed, but realignment is restricted by Ausgrid requirements, and alternate installation techniques are not viable due to traffic, property access constraints, and greater installation impacts on noise and vibration.

Tree 2 requires removal prior to works. Trees 4-21 will likely be removed as works progress. Retention of these trees will be attempted utilising the methods decribed in the recommendations of this report, but with trenching required in

close proximity of the trees, it is expected that the majority of these will be removed.

If significant root systems are encountered, an arborist will be consulted to recommend the approporiate course of action (in accordance with Ausgrid's network Standard NS174C) and a subseqeunt report prepared and submitted to DP&E prior to removal..

Map 7 St Peters trees surveyed.

ST PETERS HVC INSTALLATION

NO	BOTANICAL NAME	HEIGHT	SPREAD	DBH (mm)	HEALTH	STRUCTURE	TPZ (m)	SRZ Radius (m)	RETENTION VALUE	OUTCOME	Easting	Northing	MSL
1	Prunus species	4	2	100	MODERATE	MODERATE	2	1.5	MEDIUM	RETAIN	331206.678	6245768.75	11.792
2	Pyrus calleryana	6	2	150	MODERATE	MODERATE	2	1.5	MEDIUM	REMOVE	331212.649	6245762.23	11.567
3	Callistemon salignus	4	6	300	GOOD	GOOD	3.6	2	MEDIUM	RETAIN	331343.537	6245804.1	13.46
4	Syzigium species	4	2	100	GOOD	GOOD	2	1.5	MEDIUM	REMOVE	331376.721	6245858.93	17.226
5	Callistemon viminalis	4	4	250	MODERATE	MODERATE	3	1.85	MEDIUM	REMOVE	331366.893	6245869.92	17.613
6	Callistemon viminalis	5	10	500	GOOD	GOOD	6	2.47	MEDIUM	REMOVE	331330.682	6245910.25	18.334
7	Callistemon viminalis	4	5	275	MODERATE	MODERATE	9	2.93	MEDIUM	REMOVE	331300.359	6245945.73	17.695
8	Callistemon viminalis	5	4	250	MODERATE	MODERATE	3	1.85	MEDIUM	REMOVE	331293.82	6245954.02	18.064
9	Callistemon viminalis	5	4	300	MODERATE	MODERATE	3.6	2	MEDIUM	REMOVE	331288.05	6245960.99	17.891
10	Callistemon viminalis	4	5	250	MODERATE	MODERATE	3	1.85	MEDIUM	REMOVE	331272.245	6245979.57	17.614
11	Callistemon viminalis	3	2	150	MODERATE	MODERATE	2	1.5	MEDIUM	REMOVE	331267.901	6245984.44	17.543
12	Callistemon viminalis	3	3	150	MODERATE	MODERATE	2	1.5	MEDIUM	REMOVE	331260.524	6245993.35	18.061
13	Callistemon viminalis	4	3	150	MODERATE	MODERATE	2	1.5	MEDIUM	REMOVE	331253.093	6246000.6	18.141
14	Callistemon viminalis	5	4	300	GOOD	MODERATE	3.6	2	MEDIUM	REMOVE	331230.238	6246027.9	17.713
15	Cupaniopsis anacardioides	4	1	100	GOOD	GOOD	2	1.5	MEDIUM	REMOVE	331222.535	6246037.14	17.621
16	Tristaniopsis laurina	5	3	150	MODERATE	GOOD	2	1.5	MEDIUM	REMOVE	331214.129	6246046.58	17.77
17	Callistemon viminalis	4	4	300	MODERATE	MODERATE	3.6	2	MEDIUM	REMOVE	331206.837	6246055.26	17.29
18	Callistemon viminalis	5	3	150	MODERATE	MODERATE	2	1.5	MEDIUM	REMOVE	331183.974	6246081.28	17.18
19	Tristaniopsis laurina	4	2	150	GOOD	GOOD	2	1.5	MEDIUM	REMOVE	331171.56	6246095.86	16.764

ST PETERS HVC INSTALLATION

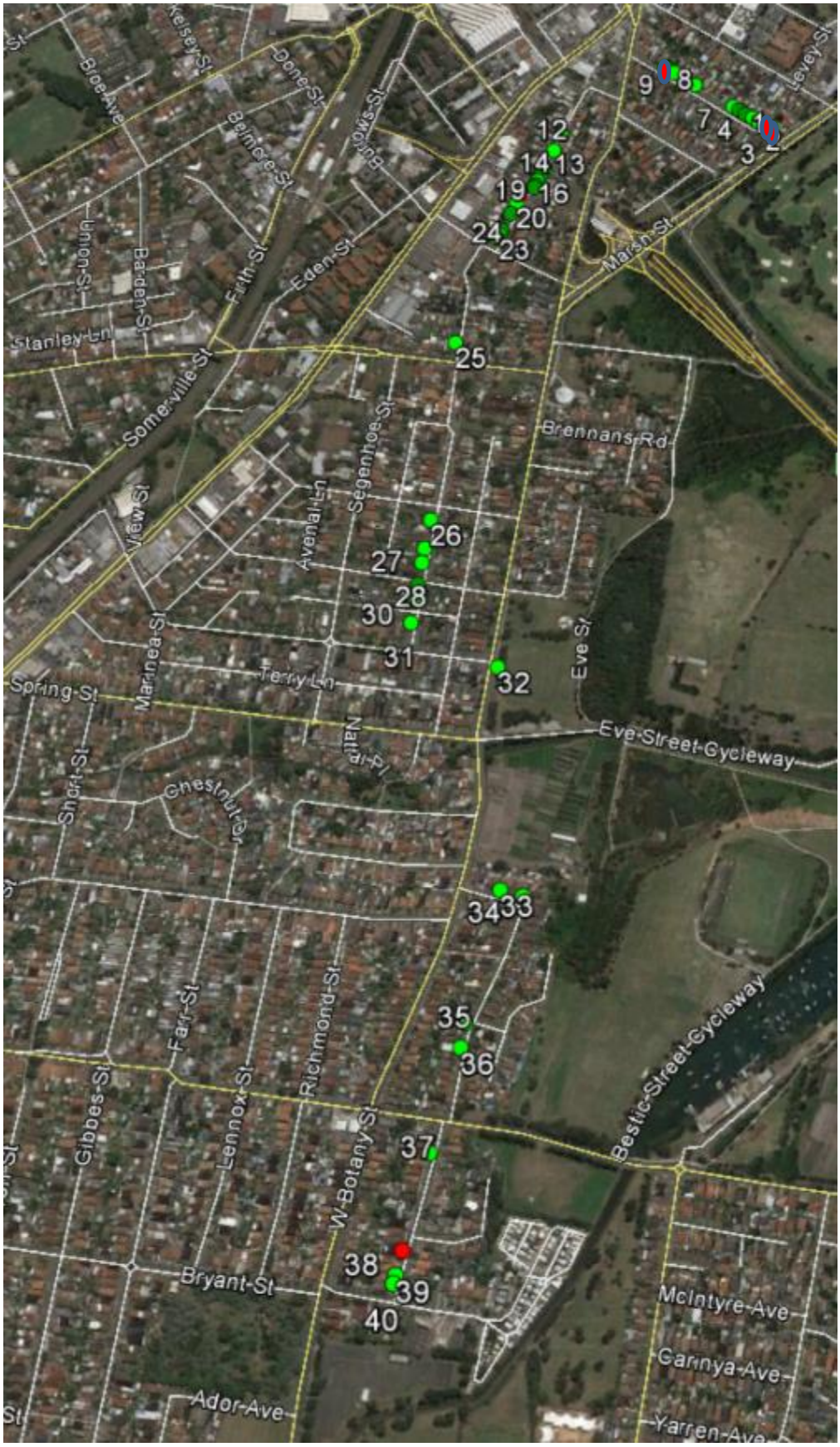
NO	BOTANICAL NAME	HEIGHT	SPREAD	DBH (mm)	HEALTH	STRUCTURE	TPZ (m)	SRZ Radius (m)	RETENTION VALUE	OUTCOME	Easting	Northing	MSL
20	Callistemon viminalis	5	4	250	MODERATE	MODERATE	3	1.85	MEDIUM	REMOVE	331165.664	6246102.38	16.834
21	Callistemon salignus	4	5	500	MODERATE	MODERATE	6	2.47	MEDIUM	REMOVE	331148.977	6246125.44	16.621
22	Melaleuca quinquenervia	5	10	700	GOOD	MODERATE	8.4	2.85	HIGH	RETAIN	331124.476	6246147.66	17.951
23	Pyrus calleryana	4	2	150	GOOD	MODERATE	2	1.5	LOW	RETAIN	331129.403	6246155.28	17.351
24	Melaleuca quinquenervia	6	12	1100	MODERATE	MODERATE	13.2	3.44	MEDIUM	RETAIN	331135.139	6246159.32	16.798
25	Melaleuca quinquenervia	8	12	1000	GOOD	MODERATE	12	3.31	HIGH	RETAIN	331150.674	6246172.44	12.633
26	Pyrus calleryana	5	2	150	GOOD	MODERATE	2	1.5	MEDIUM	RETAIN	331162.153	6246181.95	15.408
27	Melaleuca quinquenervia	8	12	950	MODERATE	MODERATE	11.4	3.24	HIGH	RETAIN	331175.444	6246190.95	14.692
28	Pyrus calleryana	5	2	150	MODERATE	MODERATE	2	1.5	MEDIUM	RETAIN	331181.647	6246194.78	15.086
29	Eucalyptus species	15	13	850	GOOD	MODERATE	10.2	3.09	HIGH	RETAIN	331186.397	6246202.14	11.68
30	Ficus hillii	18	26	800	GOOD	MODERATE	9.6	3.01	HIGH	RETAIN	331213.275	6246237.2	12.984
31	Ficus hillii	17	26	1200	GOOD	MODERATE	14.4	3.57	HIGH	RETAIN	331219.821	6246237.17	12.997
32	Ficus hillii	18	25	1250	MODERATE	MODERATE	15	3.36	HIGH	RETAIN	331225.047	6246237.05	13.048
33	Ficus hillii	16	27	1300	GOOD	MODERATE	15	3.69	HIGH	RETAIN	331225.763	6246244.32	14.265
34	Pyrus calleryana	4	2	100	GOOD	GOOD	2	1.5	LOW	RETAIN	331229.483	6246239.53	12.223
35	Pyrus calleryana	4	2	100	GOOD	GOOD	2	1.5	LOW	RETAIN	331233.503	6246244.96	12.446
36	Pyrus calleryana	4	3	150	MODERATE	MODERATE	2	1.5	MEDIUM	RETAIN	331238.885	6246249.04	7.33
37	Pyrus calleryana	5	4	200	GOOD	MODERATE	2.4	1.68	MEDIUM	RETAIN	331244.293	6246253.22	11.97
38	Pyrus calleryana	5	3	200	GOOD	MODERATE	2.4	1.68	MEDIUM	RETAIN	331252.269	6246261.9	14.991

Site 3: WestConnex Stg 2 Establish two HVC "KL" type kiosk S.76825 Marsh Valda No 2. WestConnex Stg 2 March Ave Wolli Creek. Site plans 1 – 13 by UEA Electrical.

Map 8 Route of Marsh Valda proposed HVC.

Trees located within close proximity to the proposed installation line have been included within this document. In some cases, installed conduit already exists and will be used to install cable (cable pulling via access pits). In these locations disturbance to existing trees will not occur and these trees have not been surveyed.

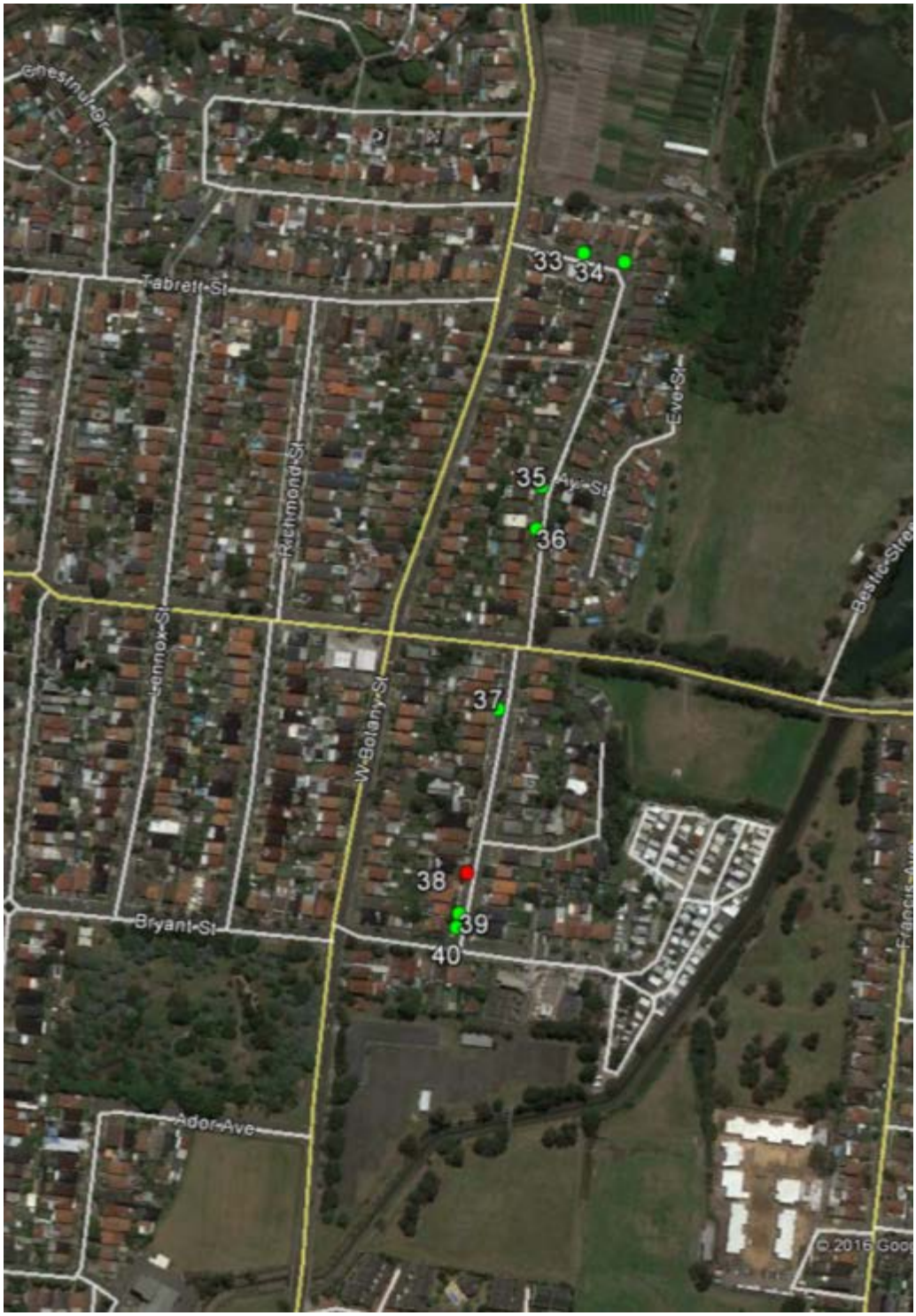
In total forty (40) trees were surveyed for this section of HVC installation. Five (5) trees require removal, No's 01, 02, 10, 19 & 38.



Map 9 Marsh Valda overall view of trees surveyed.

Map 10 Marsh Valda close up view of trees surveyed.

Map 11 Marsh Valda close up view of trees surveyed.



Map 12 Marsh Valda close up view of trees surveyed.

ARNCLIFFE HV INSTALLATION

NO	BOTANICAL NAME	HEIGHT	SPREAD	DBH (mm)	HEALTH	STRUCTURE	TPZ (m)	SRZ Radius (m)	OTHER NOTES	RETENTION VALUE	OUTCOME	Easting	Northing	MSL
1	Lophostemon confertus	7	5	500	MODERATE	MODERATE	6	2.47	Significant root loss likely from proposed under-bore	MEDIUM	REMOVE	329494.726	6243420.236	2.349
2	Callistemon viminalis	7	3	300	MODERATE	MODERATE	3.6	2	Significant root loss likely from proposed under-bore	MEDIUM	REMOVE	329487.894	6243424.178	2.328
3	Callistemon viminalis	4	3	250	MODERATE	MODERATE	3	1.85		MEDIUM	RETAIN	329476.259	6243431.573	2.398
4	Callistemon viminalis	4	2	150	MODERATE	POOR	2	1.5		LOW	RETAIN	329467.044	6243438.275	0.948
5	Callistemon viminalis	4	2	275	MODERATE	MODERATE	3.3	1.92		MEDIUM	RETAIN	329454.769	6243444.239	2.602
6	Callistemon viminalis	3	2	150	MODERATE	MODERATE	2	1.5		MEDIUM	RETAIN	329444.361	6243451.351	2.95
7	Callistemon viminalis	3	2	100	MODERATE	MODERATE	2	1.5		LOW	RETAIN	329434.259	6243457.603	3.187
8	Callistemon viminalis	4	3	275	MODERATE	MODERATE	3.3	1.92		MEDIUM	RETAIN	329372.672	6243496.548	4.24
9	Callistemon viminalis	5	3	250	MODERATE	MODERATE	3	1.85		MEDIUM	RETAIN	329338.194	6243517.894	5.579
10	Corymbia citriodora	15	14	650	GOOD	GOOD	7.8	2.76	Private tree No 4 Flora St	HIGH	REMOVE	329329.44	6243526.313	6.104
11	Callistemon viminalis	5	3	150	MODERATE	MODERATE	2	1.5		MEDIUM	RETAIN	329324.063	6243526.531	5.934
12	Lophostemon confertus	8	11	450	MODERATE	MODERATE	5.4	2.37		MEDIUM	RETAIN	329162.931	6243399.858	21.395
13	Callistemon citrinus	3	2	120	MODERATE	MODERATE	2	1.5		LOW	RETAIN	329150.83	6243373.619	19.209
14	Callistemon viminalis	4	2	150	MODERATE	MODERATE	2	1.5		MEDIUM	RETAIN	329136.948	6243344.717	17.473
15	Callistemon salignus	4	3	400	MODERATE	MODERATE	4.8	2.25		MEDIUM	RETAIN	329131.669	6243333.537	17.346
16	Callistemon viminalis	4	2	150	GOOD	GOOD	2	1.5		MEDIUM	RETAIN	329126.115	6243322.124	16.447
17	Callistemon viminalis	3	2	100	MODERATE	MODERATE	2	1.5		LOW	RETAIN	329123.518	6243316.404	16.119
18	Callistemon species	4	3	200	MODERATE	MODERATE	2.4	1.68		MEDIUM	RETAIN	329121.623	6243311.973	16.018
19	Callistemon viminalis	4	2	300	POOR	POOR	3.6	2	Hazardous tree not worth retaining.	LOW	REMOVE	329099.65	6243297.763	16.604
20	Callistemon viminalis	3	2	150	POOR	POOR	2	1.5		LOW	RETAIN	329093.959	6243284.748	16.293

ARNCLIFFE HV INSTALLATION

NO	BOTANICAL NAME	HEIGHT	SPREAD	DBH (mm)	HEALTH	STRUCTURE	TPZ (m)	SRZ Radius (m)	OTHER NOTES	RETENTION VALUE	OUTCOME	Easting	Northing	MSL
21	Callistemon viminalis	4	3	275	MODERATE	MODERATE	3.3	1.92		MEDIUM	RETAIN	329085.661	6243266.675	16.517
22	Leptospermum petersonii	3	2	100	MODERATE	MODERATE	2	1.5		LOW	RETAIN	329072.784	6243238.848	16.125
23	Callistemon viminalis	5	2	250	MODERATE	MODERATE	3	1.85		MEDIUM	RETAIN	329069.093	6243230.366	16.513
24	Callistemon viminalis	4	3	250	GOOD	MODERATE	3	1.85		MEDIUM	RETAIN	329066.343	6243224.884	16.205
25	Eucalyptus microcorys	20	14	650	GOOD	GOOD	7.8	2.76		HIGH	RETAIN	329007.852	6243048.73	16.888
26	Lophostemon confertus	15	10	600	GOOD	MODERATE	7.2	2.67		MEDIUM	RETAIN	328983.075	6242759.109	15.403
27	Lophostemon confertus	12	10	800	GOOD	MODERATE	9.6	3.01		MEDIUM	RETAIN	328975.926	6242713.681	14.33
28	Lophostemon confertus	6	3	400	GOOD	MODERATE	4.8	2.25		MEDIUM	RETAIN	328972.529	6242691.498	13.684
29	Photinia robusta	4	4	300	MODERATE	GOOD	3.6	2		LOW	RETAIN	328967.459	6242657.944	9.624
30	Lophostemon confertus	15	12	650	GOOD	MODERATE	7.8	2.76		HIGH	RETAIN	328964.015	6242633.694	8.172
31	Lophostemon confertus	4	2	350	POOR	POOR	4.2	2.13	Trees been lopped.	LOW	RETAIN	328958.698	6242598.488	6.614
32	Eucalyptus microcorys	16	7	500	GOOD	GOOD	6	2.47		HIGH	RETAIN	329093.288	6242529.205	3.117
33	Lophostemon confertus	8	7	600	GOOD	MODERATE	7.2	2.67	Concrete recently replaced.	MEDIUM	RETAIN	329113.107	6242187.617	7.146
34	Callistemon species	4	3	250	GOOD	MODERATE	3	1.85		MEDIUM	RETAIN	329147.431	6242178.456	8.384
35	Fraxinus griffithii	5	4	300	GOOD	GOOD	3.6	2		MEDIUM	RETAIN	329069.614	6241992.911	3.235
36	Waterhousia floribunda	3	3	150	GOOD	GOOD	2	1.5		MEDIUM	RETAIN	329064.136	6241957.084	3.684
37	Callistemon viminalis	4	2	250	MODERATE	MODERATE	3	1.85		MEDIUM	RETAIN	329026.731	6241806.916	8.759
38	Callistemon viminalis	4	4	400	POOR	POOR	4.8	2.25	Decay between included stem not retainable	LOW	REMOVE	328995.534	6241670.353	11.564
39	Callistemon viminalis	4	4	250	MODERATE	MODERATE	3	1.85		MEDIUM	RETAIN	328987.278	6241636.396	10.372
40	Tristaniopsis laurina	4	4	500	MODERATE	MODERATE	6	2.47		MEDIUM	RETAIN	328984.519	6241624.826	8.664

RECOMMENDATIONS:

For the majority of the HV Installation works, excavation will be required within the Tree Protection Zone of the trees and some will also be within the Critical Root Zone. With correct care, only minor affects should occur to the majority of trees.

Prior to the commencement of works at Site 2 (St Peters), one tree requires removal (tree number 2). Trenching works along this alignment are likely to have impacts on 18 trees along Silver Street (trees 4-21) where there are significant space, access and traffic constraints. Alternative options have been assessed but are limited due to the space and environmental constraints. Whilst work will be undertaken with the intention to retain these trees, it is likely that these trees will require removal as works progress through the tree protection zone.

Prior to any works starting at Site 3 (Arncliffe HV Installation), two trees (No. 19 & 38) should be removed based on the hazardous condition of the trees. It's noted that conduit has already been installed by others past tree No 38 and no surface works will be undertaken near this tree. A large *Corymbia citrodora* tree (No 10) within the front yard of 4 Flora St Arncliffe (Site 3 - Arncliffe HV Installation) will be adversely affected by trenching within the Critical Root Zone. Removal of this tree would be the best option and permission has been granted for the trees removal by the owners. Two trees near the intersection of Marsh St and Flora Street require removal due to the required location of the underbore for crossing Marsh Street. Alternative locations for the bore were investigated, but a feasible replacement with less interference with trees could not be identified.

The following recommendations should be implemented:

- In accordance with NS174C Ausgrid standard, no roots greater than 50mm shall be cut without consultation and advice from the site arborist.
- Trenches should not be open for more than 24 hours. If an extended period of time is required to have a trench open then hessian will be placed over the exposed roots and kept moist but not saturated.
- No storage of soil or any other material will be permitted against any tree.
- When excavators or any other machinery are working under the canopy of the tree the exhaust must be directed away from the canopy.
- The site arborist will be consulted when significant root systems are encountered during trenching (as per Ausgrid Network Standard NS174C).
- Any tree roots that are cut must be undertaken with a sharp hand saw. Decay is often transported through damaged roots.
- Once all the excavation works are completed a plant health care tonic should be undertaken with a product to help stimulate root growth (Seasol).

If you require any further information in relation to this report, please contact us on 1300 737 674 or 0418 474796.

Director Australian Tree Consultants
Registered Consulting Arborist No 1268
BA (L) Major in Wilderness Management/Outdoor Education
Diploma Horticulture – Arboriculture (Level 5)
Arborist/ Tree Surgeon/ Horticulturist
Certificate IV Occupational Health & Safety

LIMITATION OF LIABILITY

Australian Tree Consultants Pty Ltd and their employees are tree specialists who use their qualifications, education, knowledge, training, diagnostic tools and experience to examine trees, recommend measures to enhance the beauty and health of trees, and attempt to reduce the risk of living near trees. Clients may choose to accept or disregard the recommendations of this assessment and report.

Australian Tree Consultants Pty Ltd and its employees cannot detect every condition that could possibly lead to the structural failure of a tree. Trees are living organisms that sometimes fail in ways the arboriculture industry does not fully understand. Conditions are often hidden within trees and below ground. Unless otherwise stated, observations have been visually assessed from ground level. Australian Tree Consultants Pty Ltd cannot guarantee that a tree will be healthy or safe under all circumstances, or for a specified period of time. Likewise, remedial treatments cannot be guaranteed.

Treatment, pruning and removal of trees may involve considerations beyond the scope of Australian Tree Consultants Pty Ltd services, such as property boundaries and ownership, disputes between neighbours, sight lines, landlord-tenant matters, and related incidents. Australian Tree Consultants Pty Ltd cannot take such issues into account unless complete and accurate information is given prior or at the time of the site inspection. Likewise Australian Tree Consultants Pty Ltd cannot accept responsibility for the authorisation or non-authorisation of any recommended treatment or remedial measures undertaken.

In the event that Australian Tree Consultants Pty Ltd recommends retesting or inspection of trees at stated intervals or installs any cable/s, bracing systems and support systems, Australian Tree Consultants Pty Ltd must inspect the system installed at intervals not greater than 12 months unless otherwise specified in written reports. It is the client's responsibility to make arrangements with Australian Tree Consultants Pty Ltd to conduct the re- inspection.

Trees can be managed, but they cannot be controlled. To live or work near a tree involves a degree of risk. The only way to eliminate all risks associated with a tree is to eliminate the tree.

All written reports must be read in their entirety, at no time shall part of the written assessment be referred to unless taken in full context of the whole written report.

If this written report is to be used in a court of law or any legal situation Australian Tree Consultants Pty Ltd must be advised in writing prior to the written assessment being presented in any form to any other party.

Appendix 1

Protection of Trees on Development Sites

AS 4970—2009
(Incorporating Amendment No. 1)

AS 4970—2009

Australian Standard®

Protection of trees on development sites

This Australian Standard® was prepared by Committee EV-018 (formerly BD-068), Arboriculture. It was approved on behalf of the Council of Standards Australia on 31 July 2009.
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- Australian Institute of Building Surveyors
- Australian Institute of Horticulture
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- Australian Local Government Association
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- Institute of Australian Consulting Arboriculturists
- International Society of Arboriculture (Australia Chapter)
- Local Government Tree Resources Association
- National Arborists Association of Australia
- Nursery and Garden Industry Australia
- Parks and Leisure Australia
- TAFE NSW
- The University of Melbourne
- Water Services Association of Australia

Additional Interests:

- National Trusts of Australia NSW
- Wollongong City Council

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AS 4970—2009
(Incorporating Amendment No. 1)

Australian Standard®

Protection of trees on development sites

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PREFACE

This Standard was prepared by the Standards Australia Committee EV-018, Arboriculture.

This Standard incorporates Amendment No. 1 (March 2010). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

This Standard provides guidance for arborists, architects, builders, engineers, land managers, landscape architects and contractors, planners, building surveyors, those concerned with the care and protection of trees, and all others interested in integration between trees and construction.

This document describes the best practices for the planning and protection of trees on development sites. The procedures described are based on plant biology and current best practices as covered in recently published literature.

The assistance obtained from the 1991 and 2005 editions of BS 5837, *Trees in relation to construction—Recommendation*, along with Matheny and Clark (1998)* and Mattheck and Breloer (1994)* is acknowledged.

The term 'informative' has been used in this Standard to define the application of the appendix to which it applies. An 'informative' appendix is only for information and guidance.

* See bibliography in Appendix E for details.

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FOREWORD

Landscape design is an important component of most development. Established trees of appropriate species and sound structure are beneficial components of the built environment and a potential asset to any development site. Trees may be retained because of their—

(a) aesthetic qualities;

(b) heritage values;

(c) ecosystem benefits, including—

  (i) stormwater management;

  (ii) shade and heat reduction qualities;

  (iii) wildlife habitat and biodiversity;

  (iv) carbon dioxide absorption;

  (v) particulate pollution capture;

  (vi) salt wind protection; and

(d) social and psychological values.

A living tree is a dynamic organism that needs specific environmental conditions to continue healthy, stable growth. It is rarely possible to repair stressed and injured trees, so substantial injury needs to be avoided during all stages of development and construction. For trees to be retained and their requirements met, procedures must be in place to protect trees at every stage of the development process. This should be taken into account at the earliest planning stage of any outdoor event or design of a development project where trees are involved.

Trees and their root systems may occupy a substantial part of any development site and because of their potential size, can have a major influence on planning the use of the site.

Existing trees of appropriate species and sound structure can significantly enhance new development by providing immediate benefits such as shade and stormwater reduction as well as complementing new development.

Most trees will take many years and possibly decades to establish but can be injured or killed in a very short time as their vulnerability is commonly not understood. This is especially so in relation to tree root systems which cannot usually be seen. Irreparable injury frequently occurs in the early stages of site occupation and remedial measures routinely fail.

Early identification and protection of important trees on development sites is essential from the outset and will minimize the problems of retaining inappropriate trees.

Successful long term retention of trees on development sites depends on an acceptance and acknowledgment of the constraints and benefits that existing trees generate. Protecting trees in accordance with this Standard may influence design and construction costs and this should be considered in project budgets and contracts. The gains and benefits of retaining trees will accrue if the measures detailed in this Standard are applied.

STANDARDS AUSTRALIA

Australian Standard
Protection of trees on development sites

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard provides guidance on the principles for protecting trees on land subject to development. It follows, in sequence, the stages of development from planning to implementation.

This Standard aims to assist those concerned with trees in relation to development. Where development is to occur, the Standard provides guidance on how to decide which trees are appropriate for retention, and on the means of protecting those trees during construction work. It does not argue for or against development, or for the removal or retention of trees nor does it consider the monetary value of trees. The Standard does not apply to the establishment of new trees.

1.2 APPLICATION

This Standard gives guidance to horticulturists, arborists, architects, builders, engineers, land managers, landscape architects, contractors, planners, determining authorities, building surveyors, certifiers, those concerned with the care and protection of trees, and all others involved in the management of trees and development.

1.3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS
1319 Safety signs for the occupational environment

4373 Pruning of amenity trees

4454 Composts, soil conditioners and mulches

4687 Temporary fencing and hoardings

1.4 DEFINITIONS

For the purpose of this Standard, the following definitions apply:

1.4.1 Determining authority

Those bodies responsible for issuing approvals.

1.4.2 Development

Includes the following:

(a) The use of land (e.g. festival events, use of park areas and other events) that requires approval.

(b) The subdivision of land.

(c) The erection of a building.

(d) The carrying out of a work.

(e) The demolition of a building or works.

(f) Road works.

(g) The installation of utilities and services.

(h) Any other act, matter or thing as defined by the relevant legislation.

1.4.3 Diameter at breast height (DBH)

The nominal trunk diameter at 1.4 m above ground level determined from the circumference of the trunk divided by *pi* (π) (see Appendix A).

1.4.4 Project arborist

The person responsible for carrying out the tree assessment, report preparation, consultation with designers, specifying tree protection measures, monitoring and certification. The project arborist will be suitably experienced and competent in arboriculture, having acquired through training, qualification (minimum Australian Qualification Framework (AQF) Level 5, Diploma of Horticulture (Arboriculture)) and/or equivalent experience, the knowledge and skills enabling that person to perform the tasks required by this Standard.

1.4.5 Structural root zone (SRZ)

The area around the base of a tree required for the tree's stability in the ground. The woody root growth and soil cohesion in this area are necessary to hold the tree upright. The SRZ is nominally circular with the trunk at its centre and is expressed by its radius in metres.

This zone considers a tree's structural stability only, not the root zone required for a tree's vigour and long-term viability, which will usually be a much larger area.

1.4.6 Tree

Long lived woody perennial plant greater than (or usually greater than) 3 m in height with one or relatively few main stems or trunks (or as defined by the determining authority).

1.4.7 Tree protection zone (TPZ)

A specified area above and below ground and at a given distance from the trunk set aside for the protection of a tree's roots and crown to provide for the viability and stability of a tree to be retained where it is potentially subject to damage by development.

1.4.8 Vigour

Ability of a tree to sustain its life processes.

The term 'vigour' in this document is synonymous with commonly used terms such as 'health' and 'vitality'.

1.4.9 Work

Any physical activity in relation to land that is specified by the determining authority.

SECTION 2 PLANNING AND THE TREE MANAGEMENT PROCESS

2.1 TREE MANAGEMENT PROCESS

The success of the tree management process will depend on the cooperation of all involved in the design and development team. In particular, it is essential for those involved in site works to appreciate the need for maintaining the area of protection around the trees.

An example of the tree management process in relation to the stages of a typical development is set out in Table 1.

NOTE: Appendix B outlines potential damage to trees on development sites.

2.2 DETERMINING AUTHORITIES

Legal controls and liabilities under common law should be considered at the earliest stages of potential site development.

NOTE: Trees may be subject to legislation. Where development is proposed, additional protection may be appropriate and may be enforced by a determining authority.

Determining authorities have an important role in encouraging and enforcing the development process. Table 1 indicates the common stages in the development process and typical considerations and actions applicable to trees.

When development has been approved, planning conditions may be imposed for the management of trees.

TABLE 1

INDICATIVE STAGES IN DEVELOPMENT AND THE TREE MANAGEMENT PROCESS

Stage in development	Tree management process	
	Matters for consideration	Actions and certification
Planning (Sections 2 and 3)		
Site acquisition	Legal constraints	
Detail surveys	Council plans and policies Planning instruments and controls Heritage Threatened species	Existing trees accurately plotted on survey plan
Preliminary tree assessment	Hazard/risks Tree retention value	Evaluate trees suitable for retention and mark on plan Provide preliminary arboricultural report and indicative TPZs to guide development layout
Preliminary development design	Condition of trees Proximity to buildings Location of services Roads Level changes Building operations space Long-term management	Planning selection of trees for retention Design review by proponent Design modifications to minimize impact to trees

(*continued*)

TABLE 1 (*continued*)

Stage in development	Tree management process	
	Matters for consideration	**Actions and certification**
Development submission	Identify trees for retention through comprehensive arboricultural impact assessment of proposed construction. Determine tree protection measures Landscape design	Provide arboricultural impact assessment including tree protection plan (drawing) and specification
Development approval	Development controls Conditions of consent	Review consent conditions relating to trees
Pre-construction (Sections 4 and 5)		
Initial site preparation	State based OHS requirements for tree work	Compliance with conditions of consent
	Approved retention/removal	Tree removal/tree retention/transplanting
	Refer to AS 4373 for the requirements on the pruning of amenity trees	Tree pruning Certification of tree removal and pruning
	Specifications for tree protection measures	Establish/delineate TPZ Install protective measures
		Certification of tree protection measures
Construction (Sections 4 and 5)		
Site establishment	Temporary infrastructure Demolition, bulk earthworks, hydrology	Locate temporary infrastructure to minimize impact on retained trees Maintain protective measures Certification of tree protection measures
Construction work	Liaison with site manager, compliance Deviation from approved plan	Maintain or amend protective measures Supervision and monitoring
Implement hard and soft landscape works	Installation of irrigation services Control of compaction work Installation of pavement and retaining walls	Remove selected protective measures as necessary Remedial tree works Supervision and monitoring
Practical completion	Tree vigour and structure	Remove all remaining tree protection measures Certification of tree protection
Post construction (Section 5)		
Defects liability/ maintenance period	Tree vigour and structure	Maintenance and monitoring Final remedial tree works Final certification of tree condition

NOTES:

1 Owing to variations in planning legislation this table is a general indication of the process only.

2 Certification of tree protection and condition should be carried out by the project aborist.

2.3 PLANNING

2.3.1 Site survey

A detailed topographical survey should be made showing all existing site features.

NOTE: This should be made by a registered surveyor.

The survey plans should include—

(a) location of all individual trees or groups of trees and other vegetation;

(b) location of trees on land adjacent to the development site that may be impacted by the development;

(c) crown spread, measured and drawn to scale, defining the actual crown spread;

(d) other features, such as streams, creeks, watercourses, buildings and above and below ground services; and

(e) spot heights of ground level throughout the development site and specifically including level at the base of individual trees as a basis for evaluating changes in soil level around retained trees.

NOTES:

1 Before commencing this survey, advice should be sought from the project arborist to confirm relevant items for inclusion in the survey.

2 Other vegetation may need to be surveyed to meet specific provisions of the determining authority or legislation.

2.3.2 Preliminary tree assessment

The preliminary assessment of the trees should take place at the beginning of the project, once any site surveys have been completed. The purpose of this assessment is to provide quantitative and qualitative information on the trees. All trees included in the site survey should be numbered and assessed by the project arborist as the basis for deciding which trees are suitable for retention. For each tree consideration should be given to—

(a) correct botanical identification and common name;

(b) vigour;

(c) structure;

(d) dimensions, height, crown spread and DBH;

(e) age class;

(f) estimated life expectancy;

(g) heritage and/or cultural matters (refer Note 3);

(h) ecological and habitat matters (refer Note 3);

(i) the location relative to existing site features, e.g. its function as a screen or as a landmark feature;

(j) other matters relevant to the site, e.g. surface roots; and

(k) retention value.

NOTES:

1 These criteria should also be recorded for trees surveyed on adjacent properties.

2 Accuracy of the survey data to be verified by the arborist.

3 Input from other specialists may be required.

4 If trees require tagging use a temporary, non-injurious method.

5 A number of commonly used assessment methods are contained is documents listed in Appendix E.

2.3.3 Preliminary arboricultural report

Tree protection is most effective when considered at the earliest stage of development planning. The process will require reports at different stages. The most crucial reports are the Preliminary Arboricultural Report and the Arboricultural Impact Assessment.

The preliminary report is not intended to be the comprehensive tree protection report. This information is to be used by planners, architects and designers, in conjunction with any planning controls and other legislation, to develop the design layout in such a way that trees selected for retention are provided with enough space.

The report should list all the trees, providing all the details collected in the tree assessment (see Clause 2.3.2). Trees (or groups of trees) should be placed into categories based on their suitability for retention (for examples refer to documents listed in Appendix E).

Trees suitable for retention should be identified and marked on the detailed survey plan. This plan should also show the location of TPZs, trees to be transplanted and trees to be removed. TPZs are to be calculated as shown in Section 3.

2.3.4 Development design and review

The preliminary arboricultural report should guide the development layout. During the design and documentation stages, the project arborist should be involved in ongoing review of architectural, engineering (e.g. bulk earth works and construction drawings), services and landscape drawings. The purpose of this is to determine the potential impact on trees proposed to be retained.

Consideration should be given to tree sensitive measures such as pier and beam, suspended slabs, cantilevered building sections, screw piles and contiguous piling.

Service corridors should be established at the planning stage to avoid their redirection after works have commenced. It is essential that detailed plans show the routing of all services (above and below ground) in the proximity of trees.

Consideration should be given to activities required during the construction stage, such as over-excavation, scaffolding, temporary access roads, stockpiling materials, site sheds, temporary services and sediment control measures as well as the permanent elements of the development such as onsite water detention and storage.

2.3.5 Arboricultural impact assessment

The arboricultural impact assessment will be prepared once the final layout is complete. The report will identify trees to be removed, retained or transplanted. The report will identify possible impacts on trees to be retained. The report will explain design and construction methods proposed to minimize impacts on retained trees where there is encroachment into the calculated TPZ (refer to Clause 3.3.2). It will recommend measures necessary to protect the trees throughout all demolition and construction stages. Review of architectural, services and landscape plans should be included to provide an accurate impact assessment. If these plans are not available for review, it should be clearly stated in the report. Specification of tree protection measures will be included in construction documentation (refer to Section 4).

The report will include a tree protection plan (drawing) showing the TPZs for trees being retained taking into account the matters referred to in Section 3 and other protection measures. Groups of trees with overlapping TPZs may be included within a single protection area. A copy of this plan will form part of the development plans.

The tree protection plan should be included in subsequent construction documentation. The location of tree protection measures should also be shown on other documents such as demolition, bulk earth works, construction and landscape plans.

SECTION 3 DETERMINING THE PROTECTION ZONES OF THE SELECTED TREES

3.1 TREE PROTECTION ZONE (TPZ)

The tree protection zone (TPZ) is the principal means of protecting trees on development sites. The TPZ is a combination of the root area and crown area requiring protection. It is an area isolated from construction disturbance, so that the tree remains viable.

The TPZ incorporates the structural root zone (SRZ) (refer to Clause 3.3.5).

3.2 DETERMINING THE TPZ

The radius of the TPZ is calculated for each tree by multiplying its DBH × 12.

$$TPZ = DBH \times 12$$

where

DBH = trunk diameter measured at 1.4 m above ground

Radius is measured from the centre of the stem at ground level.

A TPZ should not be less than 2 m nor greater than 15 m (except where crown protection is required). Clause 3.3 covers variations to the TPZ.

The TPZ of palms, other monocots, cycads and tree ferns should not be less than 1 m outside the crown projection.

3.3 VARIATIONS TO THE TPZ

3.3.1 General

It may be possible to encroach into or make variations to the standard TPZ. Encroachment includes excavation, compacted fill and machine trenching.

3.3.2 Minor encroachment

If the proposed encroachment is less than 10% of the area of the TPZ and is outside the SRZ (see Clause 3.3.5), detailed root investigations should not be required. The area lost to this encroachment should be compensated for elsewhere and contiguous with the TPZ. Variations must be made by the project arborist considering relevant factors listed in Clause 3.3.4. The figures in Appendix D demonstrate some examples of possible encroachment into the TPZ up to 10% of the area.

3.3.3 Major encroachment

If the proposed encroachment is greater than 10% of the TPZ or inside the SRZ (see Clause 3.3.5), the project arborist must demonstrate that the tree(s) would remain viable. The area lost to this encroachment should be compensated for elsewhere and contiguous with the TPZ. This may require root investigation by non-destructive methods and consideration of relevant factors listed in Clause 3.3.4.

3.3.4 TPZ encroachment considerations

When determining the potential impacts of encroachment into the TPZ, the project arborist should consider the following:

(a) Location and distribution of the roots to be determined through non-destructive investigation methods (pneumatic, hydraulic, hand digging or ground penetrating radar). Photographs should be taken and a root zone map prepared.

NOTE: Regardless of the method, roots must not be cut, bruised or frayed during the process. It is imperative that exposed roots are kept moist and the excavation back filled as soon as possible.

(b) The potential loss of root mass resulting from the encroachment: number and size of roots.

(c) Tree species and tolerance to root disturbance.

(d) Age, vigour and size of the tree.

(e) Lean and stability of the tree.

NOTE: Roots on the tension side are likely to be most important for supporting the tree and are likely to extend for a greater distance.

(f) Soil characteristics and volume, topography and drainage.

(g) The presence of existing or past structures or obstacles affecting root growth.

(h) Design factors.

Tree sensitive construction measures such as pier and beam, suspended slabs, cantilevered building sections, screw piles and contiguous piling can minimize the impact of encroachment.

When siting a structure near to a tree, the future growth of the tree, both above and below ground should be taken into account. Precautions should be taken at the planning and design stage to minimize potential conflict between trees and new structures.

When the root zone is reactive clay, techniques such as localized pier and beam (bridged), screwpile footings or root and soil moisture control barriers may be appropriate to minimize effects on structures.

NOTE: Collaboration may be required between the project arborist and the geotechnical or structural engineer. Further information is provided in the documents listed in Appendix E.

3.3.5 Structural root zone (SRZ)

The SRZ is the area required for tree stability. A larger area is required to maintain a viable tree.

The SRZ only needs to be calculated when major encroachment into a TPZ is proposed.

There are many factors that affect the size of the SRZ (e.g. tree height, crown area, soil type, soil moisture). The SRZ may also be influenced by natural or built structures, such as rocks and footings. An indicative SRZ radius can be determined from the trunk diameter measured immediately above the root buttress using the following formula or Figure 1. Root investigation may provide more information on the extent of these roots.

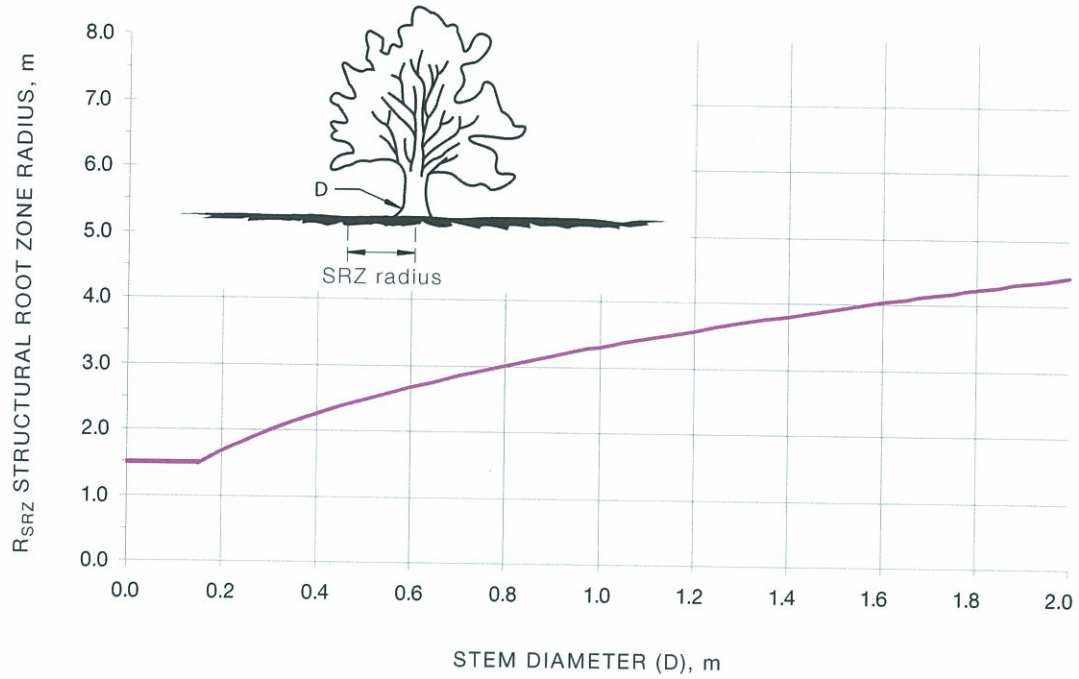
$$\text{SRZ radius} = (D \times 50)^{0.42} \times 0.64$$

where

D = trunk diameter, in m, measured above the root buttress

NOTE: The SRZ for trees with trunk diameters less than 0.15 m will be 1.5 m (see Figure 1).

A1



The curve can be expressed by the following formula:
$R_{SRZ} = (D \times 50)^{0.42} \times 0.64$

NOTES:

1 R_{SRZ} is the calculated structural root zone radius (SRZ radius).
2 D is the stem diameter measured immediately above root buttress.
3 The R_{SRZ} for trees less than 0.15 m diameter is 1.5 m.
4 The R_{SRZ} formula and graph do not apply to palms, other monocots, cycads and tree ferns.
5 This does not apply to trees with an asymmetrical root plate.

FIGURE 1 STRUCTURAL ROOT ZONE CALCULATION

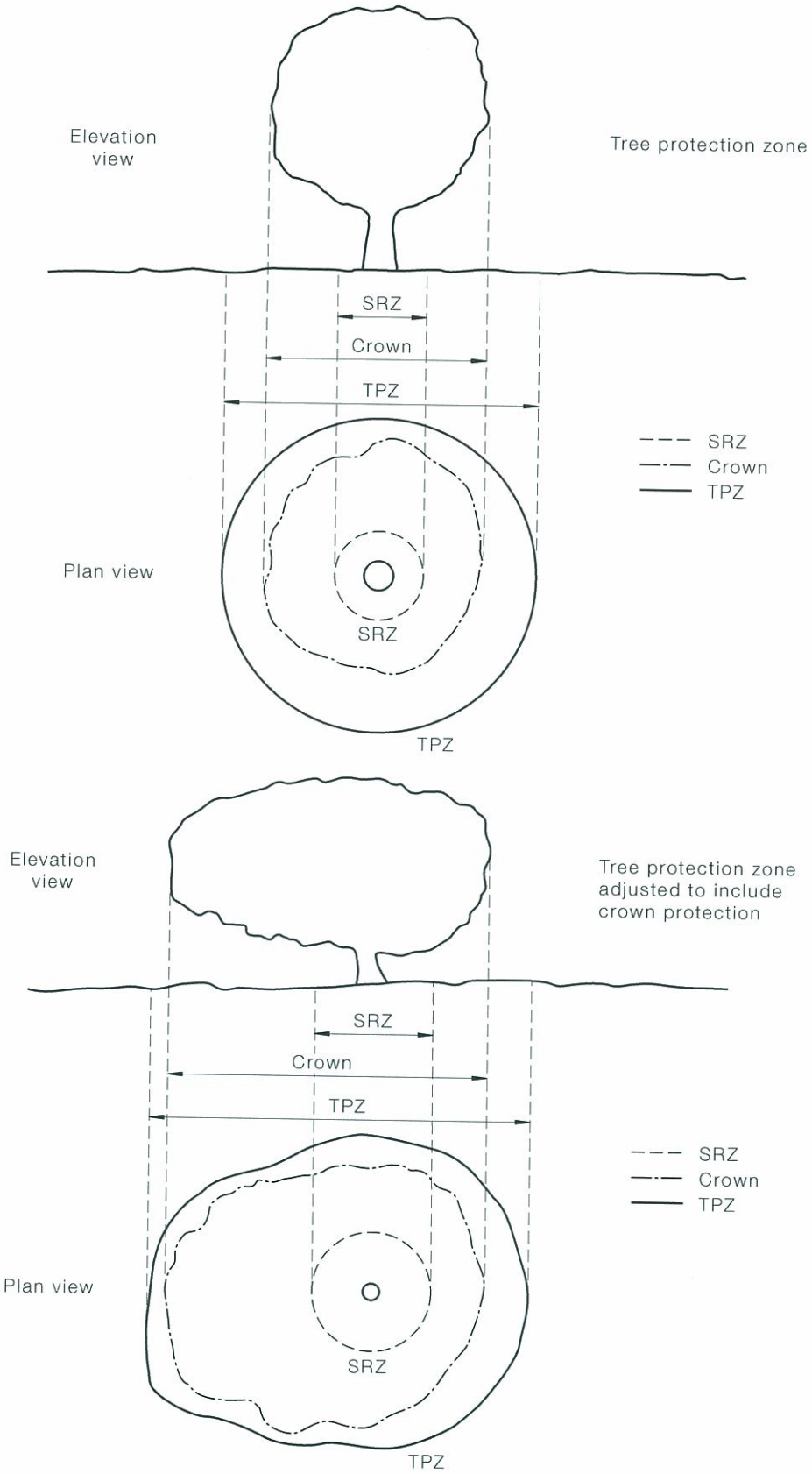
3.3.6 Crown protection

Tree crowns may be injured by machinery such as excavators, drilling rigs, cranes, trucks, hoarding installation and scaffolding. The TPZ may need to include additional protection of the above ground parts of the tree.

Where crown protection is required, it will usually be located at least one metre outside the perimeter of the crown (see Figure 2). The erection of scaffolding may require an additional setback from the edge of the crown.

Crown protection may include pruning, tying-back of branches or other measures. If pruning is required, requirements are specified in AS 4373 and should be undertaken before the establishment of the TPZ.

NOTE: Pruning may require approval from the determining authority.



NOTE: Refer to Clause 3.2 for calculation of TPZ.

FIGURE 2 INDICATIVE TREE PROTECTION ZONE

SECTION 4 TREE PROTECTION MEASURES

4.1 GENERAL

Tree protection measures include a range of activities and structures. Structures are used to identify and isolate the TPZ (refer to Section 3). These measures are identified in the arboricultural impact assessment and tree protection plan.

The TPZ is a restricted area usually delineated by protective fencing (or use of an existing structure such as an existing fence or wall). It is installed prior to site establishment and retained intact until completion of the works.

Some works and activities within the TPZ may be authorized by the determining authority. These must be supervised by the project arborist. Any additional encroachment that becomes necessary as the site works progress must be reviewed by the project arborist and be acceptable to the determining authority before being carried out.

Approved tree removal and pruning should be carried out before the installation of tree protection measures.

4.2 ACTIVITIES RESTRICTED WITHIN THE TPZ

Activities generally excluded from the TPZ include but are not limited to—

(a) machine excavation including trenching;

(b) excavation for silt fencing;

(c) cultivation;

(d) storage;

(e) preparation of chemicals, including preparation of cement products;

(f) parking of vehicles and plant;

(g) refuelling;

(h) dumping of waste;

(i) wash down and cleaning of equipment;

(j) placement of fill;

(k) lighting of fires;

(l) soil level changes;

(m) temporary or permanent installation of utilities and signs, and

(n) physical damage to the tree.

4.3 PROTECTIVE FENCING

Fencing should be erected before any machinery or materials are brought onto the site and before the commencement of works including demolition. Once erected, protective fencing must not be removed or altered without approval by the project arborist. The TPZ should be secured to restrict access.

AS 4687 specifies applicable fencing requirements. Shade cloth or similar should be attached to reduce the transport of dust, other particulate matter and liquids into the protected area.

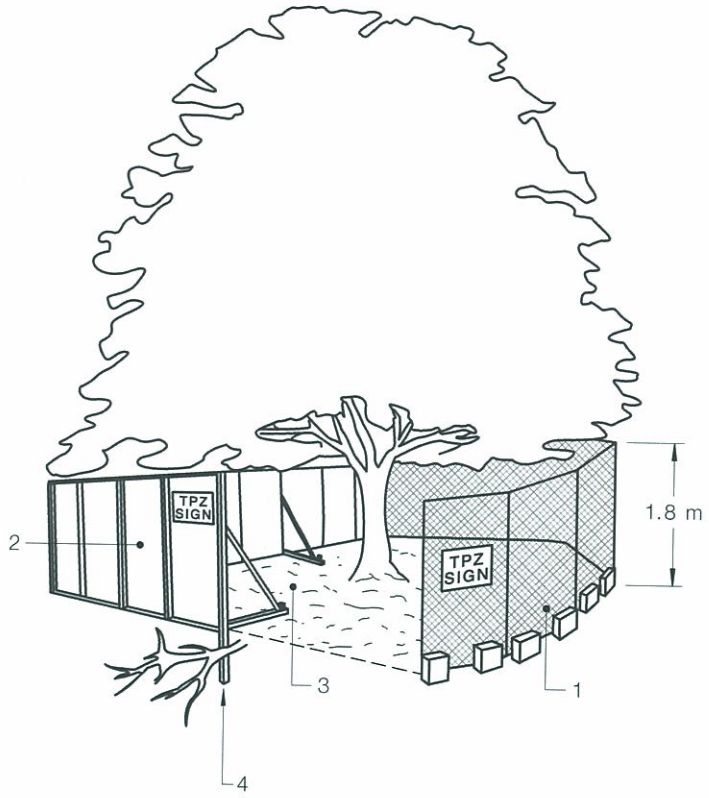
Fence posts and supports should have a diameter greater than 20 mm and be located clear of roots.

Existing perimeter fencing and other structures may be suitable as part of the protective fencing.

Figure 3 indicates an example of protective fencing.

4.4 SIGNS

Signs identifying the TPZ should be placed around the edge of the TPZ and be visible from within the development site (refer Figure 3). The lettering on the sign should comply with AS 1319. Appendix C provides an example of a suitable TPZ sign.



LEGEND:

1 Chain wire mesh panels with shade cloth (if required) attached, held in place with concrete feet.
2 Alternative plywood or wooden paling fence panels. This fencing material also prevents building materials or soil entering the TPZ.
3 Mulch installation across surface of TPZ (at the discretion of the project arborist). No excavation, construction activity, grade changes, surface treatment or storage of materials of any kind is permitted within the TPZ.
4 Bracing is permissible within the TPZ. Installation of supports should avoid damaging roots.

FIGURE 3 PROTECTIVE FENCING

4.5 OTHER TREE PROTECTION MEASURES

4.5.1 General

When tree protection fencing cannot be installed or requires temporary removal, other tree protection measures should be used, including those set out below.

4.5.2 Trunk and branch protection

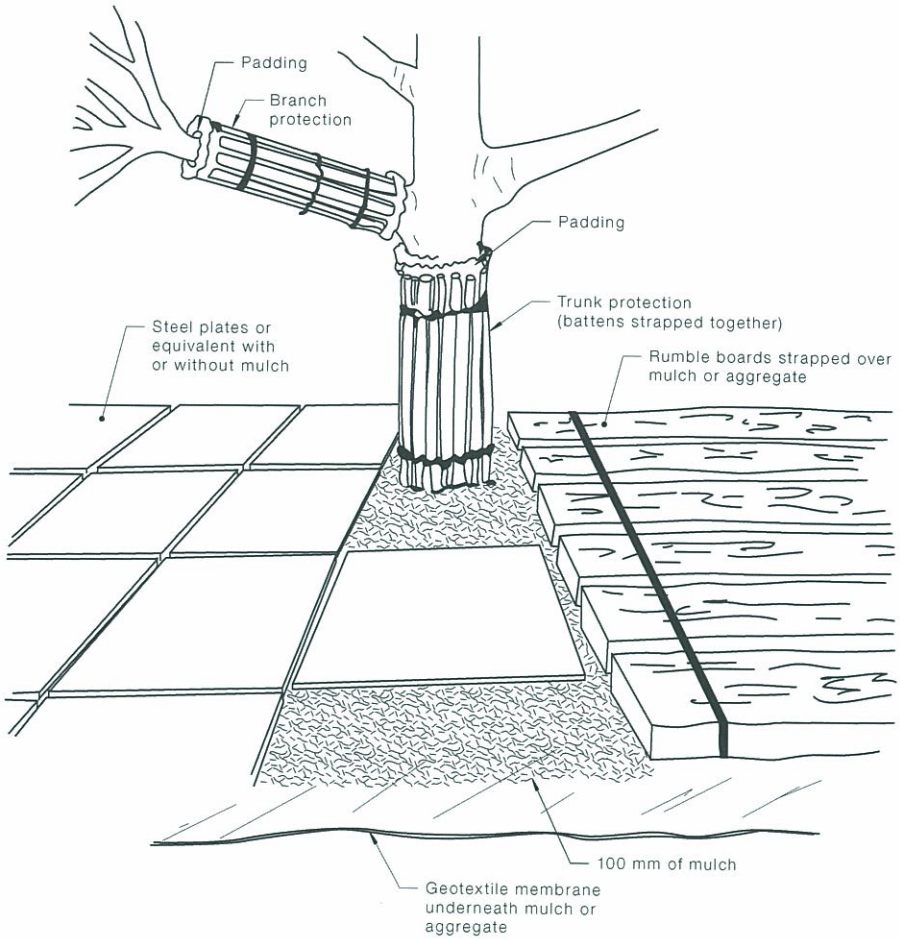
Where necessary, install protection to the trunk and branches of trees as shown in Figure 4. The materials and positioning of protection are to be specified by the project arborist. A minimum height of 2 m is recommended.

Do not attach temporary powerlines, stays, guys and the like to the tree. Do not drive nails into the trunks or branches.

4.5.3 Ground protection

If temporary access for machinery is required within the TPZ ground protection measures will be required. The purpose of ground protection is to prevent root damage and soil compaction within the TPZ. Measures may include a permeable membrane such as geotextile fabric beneath a layer of mulch or crushed rock below rumble boards as per Figure 4.

These measures may be applied to root zones beyond the TPZ.



NOTES:

1 For trunk and branch protection use boards and padding that will prevent damage to bark. Boards are to be strapped to trees, not nailed or screwed.

2 Rumble boards should be of a suitable thickness to prevent soil compaction and root damage.

FIGURE 4 EXAMPLES OF TRUNK, BRANCH AND GROUND PROTECTION

4.5.4 Root protection during works within the TPZ

Some approved works within the TPZ, such as regrading, installation of piers or landscaping may have the potential to damage roots.

If the grade is to be raised the material should be coarser or more porous than the underlying material. Depth and compaction should be minimized.

Manual excavation should be carried out under the supervision of the project arborist to identify roots critical to tree stability. Relocation or redesign of works may be required.

Where the project arborist identifies roots to be pruned within or at the outer edge of the TPZ, they should be pruned with a final cut to undamaged wood. Pruning cuts should be made with sharp tools such as secateurs, pruners, handsaws or chainsaws. Pruning wounds should not be treated with dressings or paints. It is not acceptable for roots within the TPZ to be 'pruned' with machinery such as backhoes or excavators.

Where roots within the TPZ are exposed by excavation, temporary root protection should be installed to prevent them drying out. This may include jute mesh or hessian sheeting as multiple layers over exposed roots and excavated soil profile, extending to the full depth of the root zone. Root protection sheeting should be pegged in place and kept moist during the period that the root zone is exposed.

Other excavation works in proximity to trees, including landscape works such as paving, irrigation and planting can adversely affect root systems. Seek advice from the project arborist.

4.5.5 Installing underground services within TPZ

All services should be routed outside the TPZ. If underground services must be routed within the TPZ, they should be installed by directional drilling or in manually excavated trenches.

The directional drilling bore should be at least 600 mm deep. The project arborist should assess the likely impacts of boring and bore pits on retained trees.

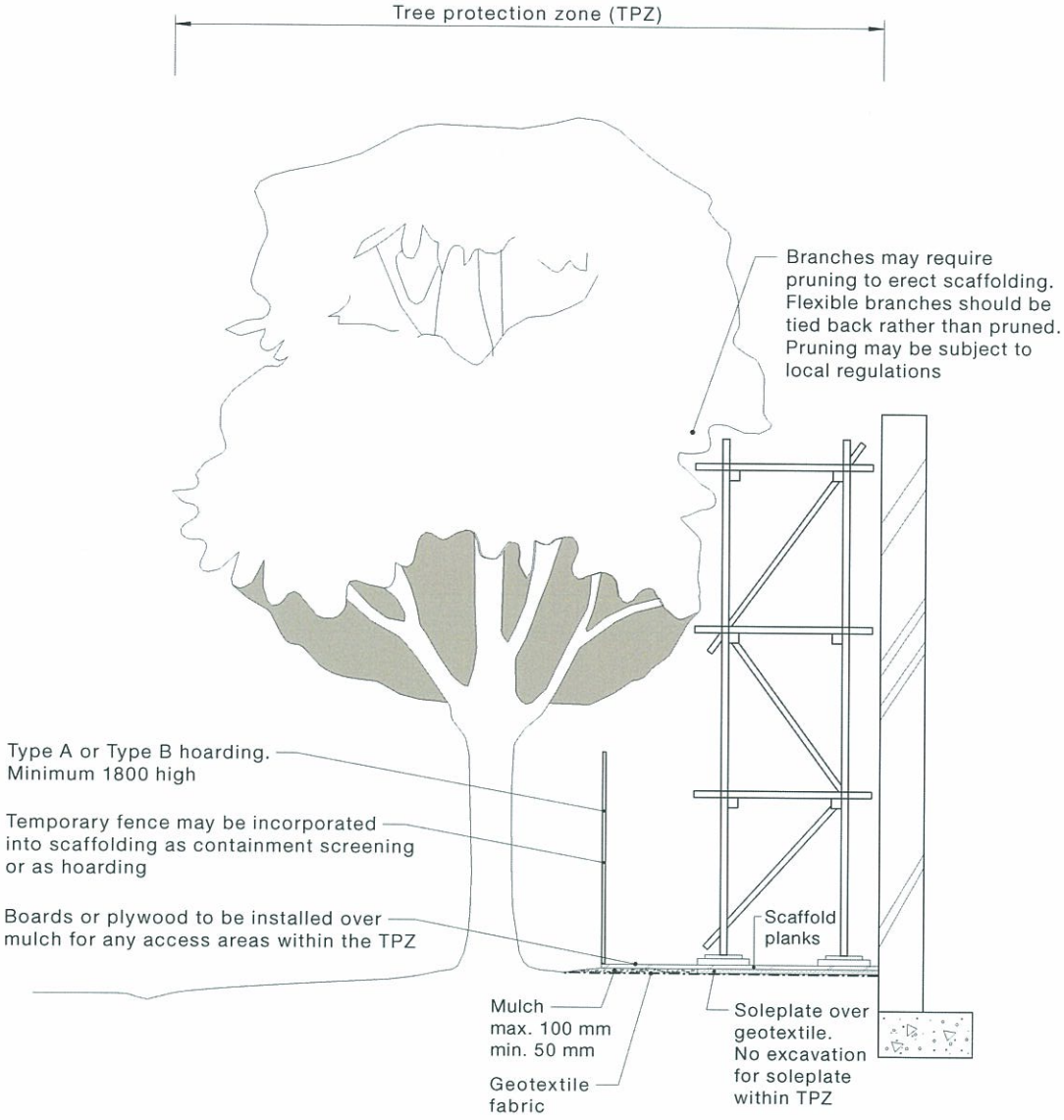
For manual excavation of trenches the project arborist should advise on roots to be retained and should monitor the works. Manual excavation may include the use of pneumatic and hydraulic tools. Refer Clause 4.5.3.

4.5.6 Scaffolding

Where scaffolding is required it should be erected outside the TPZ. Where it is essential for scaffolding to be erected within the TPZ, branch removal should be minimized. This can be achieved by designing scaffolding to avoid branches or tying back branches. Where pruning is unavoidable it must be specified by the project arborist in accordance with AS 4373.

NOTE: Pruning works may require approval by determining authority.

Ground below the scaffolding should be protected by boarding (e.g. scaffold board or plywood sheeting) as shown in Figure 5. Where access is required, a board walk or other surface material should be installed to minimize soil compaction. Boarding should be placed over a layer of mulch and impervious sheeting to prevent soil contamination. The boarding should be left in place until the scaffolding is removed.



NOTE: Excavation required for the insertion of support posts for tree protection fencing should not involve the severance of any roots greater than 20 mm in diameter, without the prior approval of the project arborist.

FIGURE 5 INDICATIVE SCAFFOLDING WITHIN A TPZ

4.6 MAINTAINING THE TPZ

4.6.1 Mulching

The area within the TPZ should be mulched. The mulch must be maintained to a depth of 50–100 mm using material that complies with AS 4454. Where the existing landscape within the TPZ is to remain unaltered (e.g. garden beds or turf) mulch may not be required.

4.6.2 Watering

Soil moisture levels should be regularly monitored by the project arborist. Temporary irrigation or watering may be required within the TPZ. An above-ground irrigation system should be installed and maintained by a competent individual.

4.6.3 Weed removal

All weeds should be removed by hand without soil disturbance or should be controlled with appropriate use of herbicide.

SECTION 5 MONITORING AND CERTIFICATION

5.1 GENERAL

There are many stages in the development process from site acquisition to completion where the project arborist is required to monitor or certify tree protection. Table 1 summarizes the process and indicates the stages that normally require certification (a written statement of compliance). This Section provides details of the monitoring and certification process.

5.2 TREE PROTECTION PLAN

The approved tree protection plan must be available onsite prior to the commencement of and during works. The tree protection plan will identify key stages where monitoring and certification will be required.

A pre-construction meeting should be attended by the site manager, the project arborist and contractors to introduce the tree protection plan and its requirements.

5.3 PRE-CONSTRUCTION

5.3.1 Tree removal and pruning

Trees for removal or transplanting should be marked onsite as per the approved tree protection plan. Before removal, the project arborist should confirm that all marked trees correspond with those shown on the schedule or plan. Other tree work may be specified in the tree protection plan.

Tree removal should be carried out prior to erection of protection fencing. Contractors should be instructed to avoid damage to trees within protection areas when removing or pruning trees. This may include restrictions of vehicle movements.

Any approved pruning required to allow for works should be done at this stage. AS 4373 specifies requirements for pruning.

Stumps to be removed from within a TPZ must be removed in a manner that avoids damaging or disturbing roots of trees to be retained.

The project arborist should supervise tree removal, transplanting and pruning and certify the works on completion.

5.3.2 Installing tree protection fencing and other protection measures

Fencing and other protection measures are to be installed in compliance with Section 4 and as detailed in the tree protection plan.

Protection measures are to be certified by the project arborist.

5.4 CONSTRUCTION STAGE

5.4.1 General

In order to ensure that protection measures are being adhered to during the pre-construction and construction stages, there should be a predetermined number of site inspections carried out by the project arborist. Matters to be monitored and reported should include tree condition, tree protection measures and impact of site works which may arise from changes to the approved plans.

If there is non-compliance with tree protection measures or if trees have been damaged, a timeframe for compliance and remedial works should be specified by the project arborist. The determining authority may need to be notified of non-compliance issues. Monitoring, reporting and certification should be carried out at the following critical stages of construction.

5.4.2 Site establishment

The project arborist will monitor the impacts of demolition, bulk earth works, installation of temporary infrastructure including bunding, sediment control works and drainage works.

The construction management plan (site establishment plan) should be checked for compliance with the tree protection plan. The construction management plan normally includes location of site sheds, stockpile areas, temporary access roads and sediment control devices.

At completion of site establishment, the project arborist should certify that tree protection measures comply with the tree protection plan.

5.4.3 Construction work

The project arborist will monitor the impacts of general construction works on retained trees. Monitoring should be done at regular intervals or in consultation with the site manager. Monitoring is to be recorded for inclusion in certification at practical completion.

Critical stages typically include installation of services, footings and slabs, scaffolding, works within the TPZ and at completion of building works.

5.4.4 Landscape works

The landscape plan should be checked for compliance with the tree protection plan. The project arborist may need to approve the staged removal of protection measures required to allow for landscape works. The project arborist should supervise any works within TPZs, including retaining walls, irrigation and lighting installation, topdressing, planting and paving. The project arborist should specify any remedial works above and below ground. Monitoring is to be recorded for inclusion in certification at practical completion.

5.4.5 Practical completion

Practical completion assumes that all construction and landscaping works are finished. At practical completion all remaining tree protection measures should be removed. The project arborist should assess tree condition and provide certification of tree protection.

5.5 POST-CONSTRUCTION

5.5.1 Defects liability period

Completion of outstanding building or landscaping works following the construction period must not injure trees.

5.5.2 Final certification

The project arborist should assess the condition of trees and their growing environment, and make recommendations for any necessary remedial actions.

Following the final inspection and the completion of any remedial works, the project arborist should certify (as appropriate) that the completed works have been carried out in compliance with the approved plans and specifications for tree protection. Certification should include a statement on the condition of the retained trees, details of any deviations from the approved tree protection measures and their impacts on trees. Copies of monitoring documentation may be required.

NOTES:

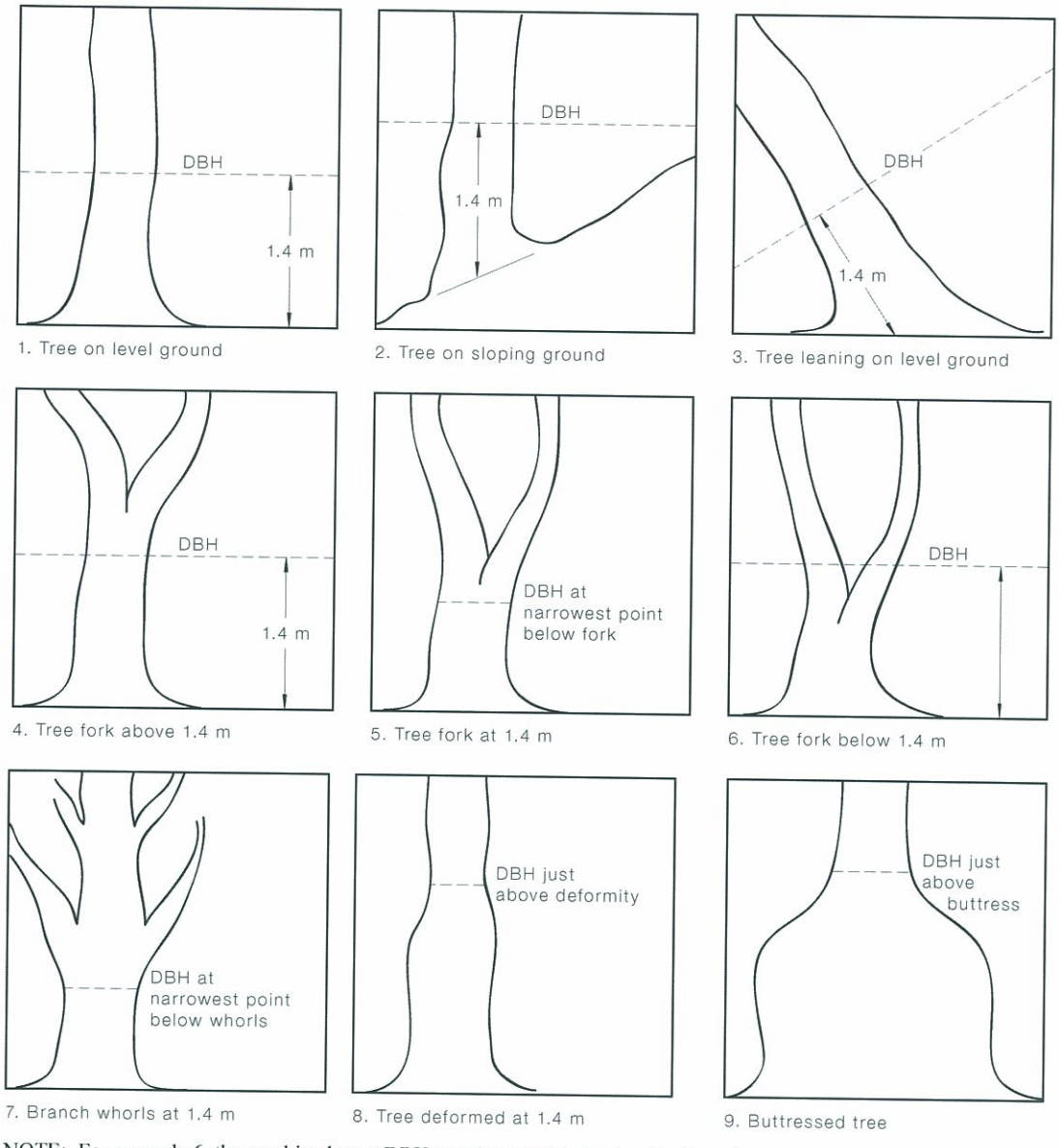
1 Remedial actions may include pruning in accordance with AS 4373 and/or soil remediation.

2 If the project arborist has not been involved throughout the project, they should have access to inspection reports by others and should review construction drawings to determine likely impacts on trees.

APPENDIX A
DIAMETER AT BREAST HEIGHT (DBH)

(Informative)

The diversity of trunk shapes, configurations and growing environments requires that DBH be measured using a range of methods to suit particular situations and Figure A1 provides examples.



NOTE: For example 6, the combined stem DBH may be calculated using the formula:

$$\text{Total DBH} = \sqrt{(\text{DBH}_1)^2 + (\text{DBH}_2)^2 + (\text{DBH}_3)^2}$$

FIGURE A1 MEASUREMENT OF DBH OF A TREE

APPENDIX B

POTENTIAL DAMAGE TO TREES ON DEVELOPMENT SITES

(Informative)

B1 INTRODUCTION

Established trees of good vigour and structure represent an asset to any development site, particularly if landscaping is a significant component of the proposed development. Trees may be retained because of their aesthetic features, for shade, for the scale that they will give to new buildings or for their historical value.

Trees are living organisms that require certain environmental conditions in order to maintain their value as an asset. As remediation of badly stressed or damaged trees is rarely successful, damage must be avoided or minimized during development. Hence, if trees are to be retained and their requirements met, procedures which ensure the protection of trees must be in place at all stages of the development including the demolition stage.

B2 BACKGROUND BIOLOGY

B2.1 General

All plants consist of three main sections: a crown (leaves), a stem or trunk and a root system. Each one of these sections carries out specific functions necessary for the survival of the tree as all of the parts interact. A tree is in a state of physiological equilibrium between the above ground and below ground sections, so that if one of these sections is damaged, the entire tree will suffer and symptoms may appear in any part of the tree.

Thus any demolition and construction operations that occur around trees must be carried out in such a way as to minimize the impact on the health of the tree.

B2.2 Leaves

The main function of leaves is photosynthesis, that is, the production of sugars. The sugars produced by the leaves (and any other green tissue) are the source of chemical energy for all living cells in the entire plant and as such are essential for the normal functioning and survival of the tree. Anything that directly or indirectly damages the leaves will interfere with photosynthesis.

B2.3 Trunks and branches

Branches and trunks are composed of many tissues with specialized functions including the bark (protection), phloem (transport of sugars from the leaves), vascular cambium (growth of new transport tissues), sapwood (transport of water and nutrients from the roots), heartwood (strength and structural support) and rays (internal transport and storage of sugars). Damage to branches or trunks may allow infection by plant pathogens (disease-causing organisms), disrupt the movement of vital materials and structurally weaken the tree.

B2.4 Roots

The main functions of roots include the uptake of water and nutrients, anchorage, storage of sugar reserves and the production of some plant hormones required by the shoots. In order for roots to function, they must be supplied with oxygen from the soil. The root system of trees consists of several 'types' of roots found in different parts of the soil and is generally much more extensive than commonly thought. The importance of roots is easily overlooked because they are not visible, that is 'out of sight, out of mind'. Damage to the root system is a common cause of tree decline and death and is the most common form of damage associated with development sites.

Root growth is opportunistic and takes place wherever the soil environment is favourable. The most limiting factor for root growth is air. A number of studies have indicated that roots are much more extensive than commonly thought. In general roots extend outward from the trunk and occupy irregularly shaped areas 4 to 7 times larger than the projected crown area with an average diameter of two or more times the height of the tree. It is a fallacy that tree roots only extend to the edge of the crown.

Root systems consist of three main parts—

(a) the structural woody roots (anchorage, storage and transport);

(b) lower order roots (anchorage, storage and transport); and

(c) non-woody roots (absorption of water and nutrients, extension, synthesis of amino acids and growth regulators) (see Figure B1).

In addition to lateral root spread being underestimated, root depth in trees has also been grossly exaggerated. Deep root systems or taproots are the exception rather than the rule. Most roots of most trees are found in the very top of the soil. The vast majority of these roots are small non-woody absorbing roots which grow upward into the very surface layers of the soil and leaf litter. This delicate, non-woody system, because of its proximity to the surface, is very vulnerable to injury.

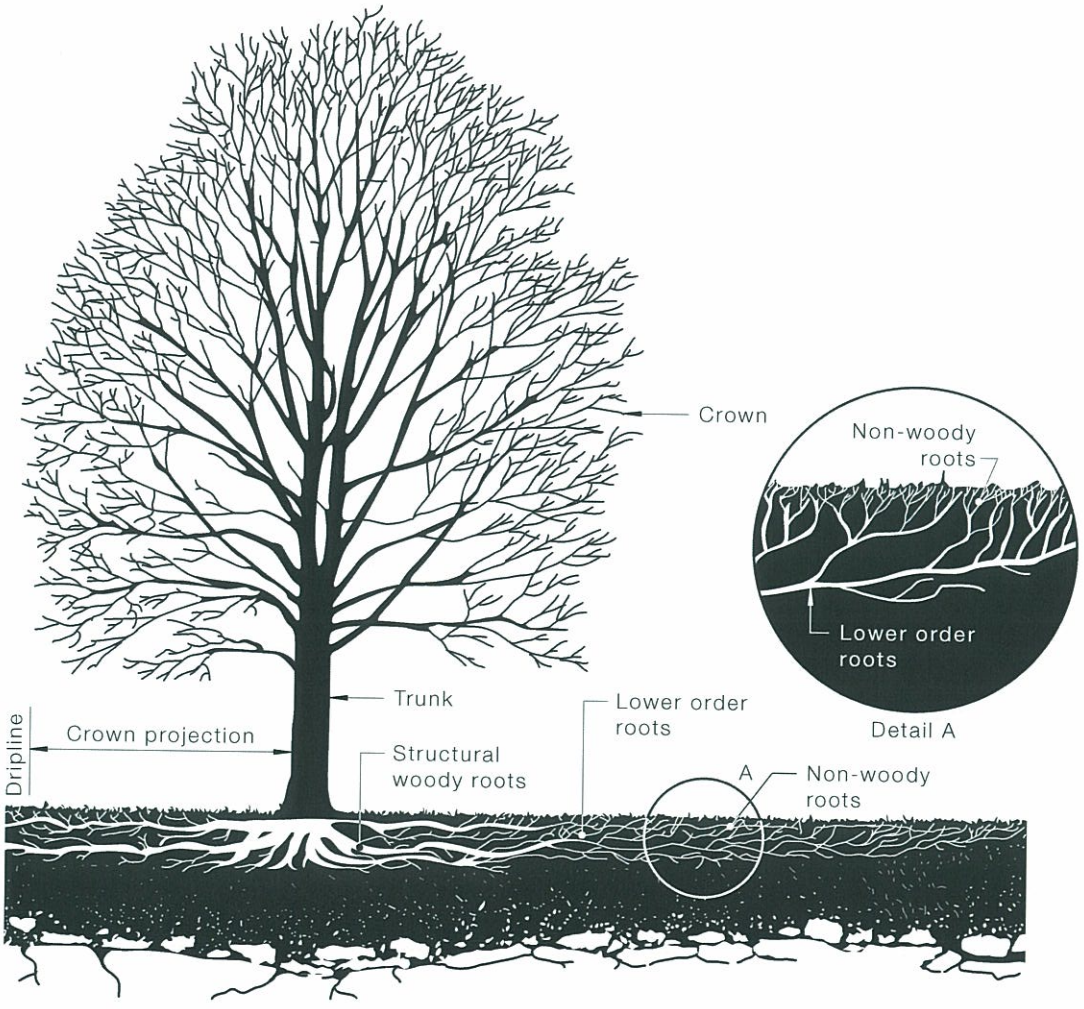


FIGURE B1 STRUCTURE OF A TREE IN A NORMAL GROWING ENVIRONMENT

B3 EFFECTS OF DEVELOPMENT ON TREES

B3.1 General

All parts of the tree may be damaged by development. Damage to any one part of the tree will affect its functioning as a whole. This Paragraph (B3) considers the possible impact of injury on the functioning of each main section of the tree. This highlights the specific protective measures that need to be undertaken.

B3.2 Crown damage

The canopy of trees can be directly or indirectly damaged. Indirect damage will occur as a result of trunk and or root damage and will not be discussed here.

Usually, foliage may be lost or damaged on development sites by pruning or mechanical injury by trucks, cranes, excavators and so on. The removal of leaves reduces the level of photosynthesis and thus the production of sugars. This in turn reduces the tree's capacity to function normally and to withstand stresses imposed by a change in its environment.

Incorrect techniques of pruning such as lopping or flush cutting may produce wounds that are susceptible to infection by wood decay organisms. Similarly, mechanical damage to branches by machinery, etc. will also create wounds. Trees automatically respond to wounding and in doing so use stored sugars. Any wound places an additional load on trees that will inevitably be stressed during construction.

B3.3 Trunk damage

Trunks of trees may be wounded mechanically during demolition and construction work. This not only predisposes a tree to potential decay but it also interferes with the transport of water, nutrients and sugars throughout the tree. Serious impacts may structurally weaken the tree.

B3.4 Root damage

Root damage is the most common cause of damage to trees on development sites. As already mentioned in Paragraph B2.4, roots are far more extensive and closer to the surface than commonly thought. Roots can be damaged in the following ways:

(a) Removed during grading, excavation and trenching for foundations services, etc.

(b) Mechanically wounded, crushed or torn.

(c) Compaction by machinery, storage of materials, and installation of work sheds.

(d) Soil buildup.

(e) Laying of pavements.

(f) Chemical contamination of the soil by solvents, fuel, oil, diesel, herbicides, cement waste, etc.

(g) Changes in air levels through changes in drainage patterns.

(h) Changes in available water.

Apart from the actual removal of roots during excavation or trenching, soil compaction is one of the major causes of root damage on development sites. Compaction is defined as the loss of large pore spaces (macropores) within the soil with a net loss of total pore space. Macropores are essential for the exchange of gases between the soil air and the atmosphere (aeration) and the removal of excess water from the soil (drainage).

Compaction results from loads or stress forces applied to the soil as well as shear forces. Both foot traffic and vehicle traffic exert both forces on soils. Vehicle traffic may cause significant compaction at depths of 150–200 mm (the area in which most absorbing roots are located). The degree of compaction will depend on weight of vehicles, number of movements, soil moisture levels and clay content. Soil handling, stockpiling and transporting also tend to lead to the breakdown of soil structure and thus to compaction. Vibration as a result of frequent traffic or adjacent construction activities will also compact soils.

The effects of compaction include—

(i) reduced aeration (oxygen levels decrease and carbon dioxide concentration increases to perhaps toxic levels);

(ii) low oxygen levels discourage root growth and thus the uptake of water and nutrients;

(iii) reduced infiltration of water into the soil and more run-off;

(iv) increased run-off increases soil losses by erosion;

(v) low oxygen levels also lead to chemical changes in the soil which can reduce the availability of some plant nutrients; and

(vi) the reduction in the number and diversity of beneficial soil organisms (including mycorrhizal fungi).

In summary, the effects of root loss or damage by any means could include—

(A) loss of stability if structural woody roots or even lower order woody roots are cut;

(B) reduction in water and nutrient uptake;

(C) an eventual loss of leaves, reduced photosynthesis and thus sugar production;

(D) decay as a result of wounding; and

(E) predisposition to soil borne pathogens.

It is commonly observed that trees may take many years to decline and eventually die from root damage.

B4 CONCLUSIONS

The negative impacts of inadequate development design, planning and supervision are cumulative and very difficult to remediate after development is completed. The best way to ensure the long term retention of established trees is to follow the guidelines outlined in this Standard.

Additional guidance may be found in the documents listed in Appendix E.

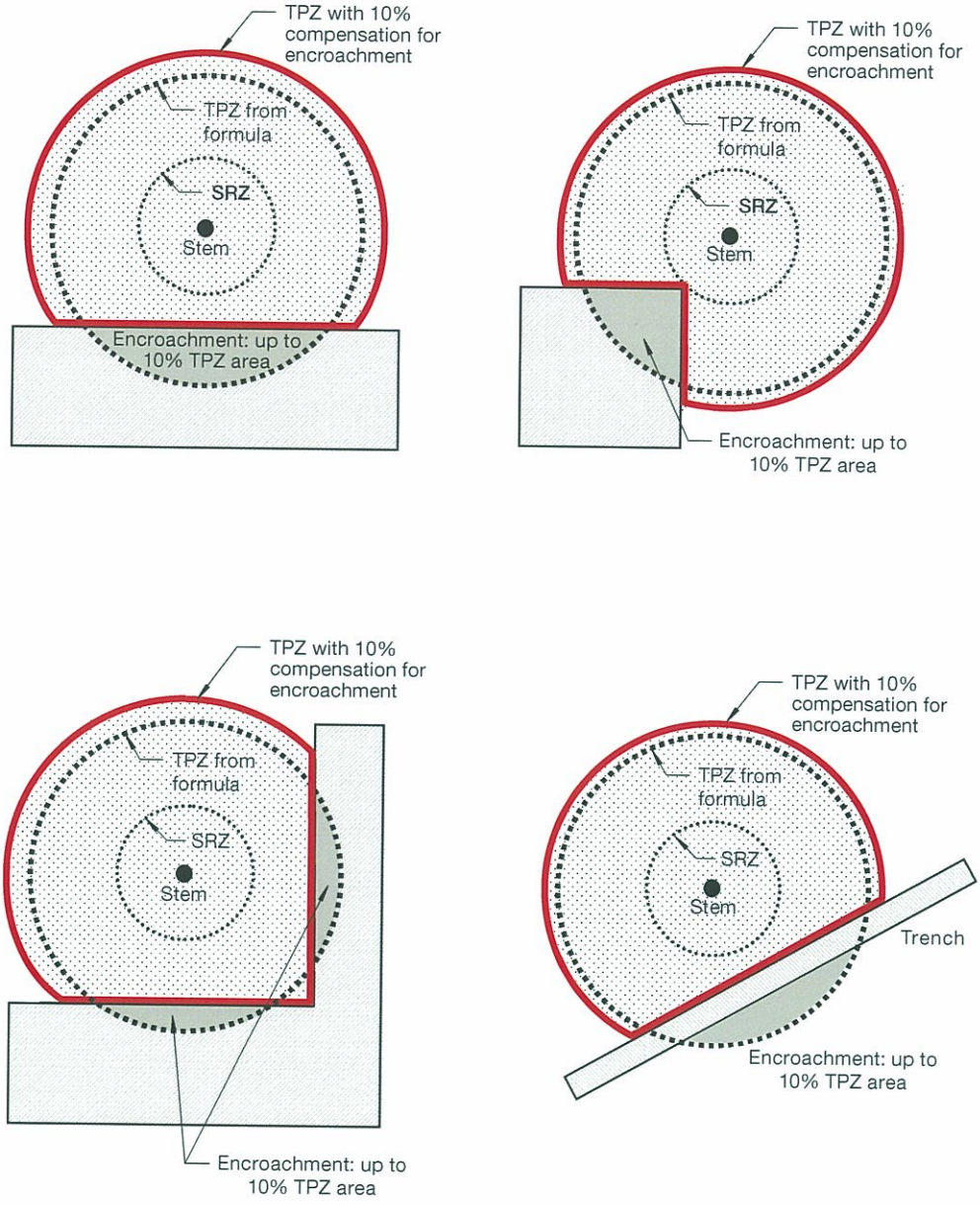
APPENDIX C
TREE PROTECTION ZONE SIGN EXAMPLE
(Informative)

A TPZ sign provides clear and readily accessible information to indicate that a TPZ has been established. Figure C1 provides an example of a suitable sign.

FIGURE C1 TREE PROTECTION ZONE SIGN

APPENDIX D
ENCROACHMENT INTO TREE PROTECTION ZONE
(Informative)

Encroachment into the tree protection zone (TPZ) is sometimes unavoidable. Figure D1 provides examples of TPZ encroachment by area, to assist in reducing the impact of such incursions.



NOTE: Less than 10% TPZ area and outside SRZ. Any loss of TPZ compensated for elsewhere.

FIGURE D1 EXAMPLES OF MINOR ENCROACHMENT INTO TPZ

APPENDIX E

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Journal of Arboriculture and Urban Forestry

Arborist News

Arboricultural Journal

Urban Forestry and Urban Greening

AMENDMENT CONTROL SHEET

AS 4970—2009

Amendment No. 1 (2010)

CORRECTION

SUMMARY: This Amendment applies to the Preface and Figure 1.

Published on 26 March 2010.

Appendix 2

Clearing Area		Retained Vegetation Identified	
ID	Coordinate	ID	Coordinate
21.	331148.977, 6246125.44	38.	331252.269, 6246261.9
20.	331165.664, 6246102.38	37.	331244.293, 6246253.22
19.	331171.56, 6246095.86	36.	331238.885, 6246249.04
18.	331183.974, 6246081.28	35.	331233.503, 6246244.96
17.	331206.837, 6246055.26	34.	331229.483, 6246239.53
16.	331214.129, 6246046.58	33.	331225.763, 6246244.32
15.	331222.535, 6246037.14	32.	331225.047, 6246237.05
14.	331230.238, 6246027.9	31.	331219.821, 6246237.17
13.	331253.093, 6246000.6	30.	331213.275, 6246237.2
12.	331260.524, 6245993.35	29.	331186.397, 6246202.14
11.	331267.901, 6245984.44	28.	331181.647, 6246194.78
10.	331272.245, 6245979.57	27.	331175.444, 6246190.95
9.	331288.05, 6245960.99	26.	331162.153, 6246181.95
8.	331293.82, 6245954.02	25.	331150.674, 6246172.44
7.	331300.359, 6245945.73	24.	331135.139, 6246159.32
6.	331330.682, 6245910.25	23.	331129.403, 6246155.28
5.	331366.893, 6245869.92	22.	331124.476, 6246147.66
4.	331376.721, 6245858.93	3.	331343.537, 6245804.1
2.	331212.649, 6245762.23	1.	331206.678, 6245768.75

No Weeds Identified
Sensitive/ No-Go Area

Trees to retain
Trees to be removed
Power alignment
Deed Boundary
Local Area Works
New M5 Main Works

0 25 50 75 100 m

St Peters Tempe HV Clearing Map